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GUIDE BOOK No. 5

EXCURSIONS in the Western Peninsula of Ontario and Manitoulin Island

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EXCURSIONS

IN THE

Western Peninsula of Ontario and Manitoulin Island

(EXCURSIONS B 4, B 7, B 9 AND C 5.)

ISSUED BY THE GEOLOGICAL SURVEY

OTTAWA
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35066—1

GUIDE BOOK No. 5.

Excursions in the Western Peninsula of Ontario and Manitoulin Island.

CONTENTS.

35066—1½

EXCURSION B 4.

SILURIAN SECTION AT THE FORKS OF CREDIT RIVER, ONTARIO.

BY

WILLIAM A. PARKS.

CONTENTS.

INTRODUCTION.

The remarks contained in the introduction to the guide book for Excursion B3 are equally applicable to the section at Credit Forks. In fact the sections at Hamilton and at the Forks of the Credit are both essential to an understanding of the formations exposed along the face of the Niagara cuesta. For the correlation of these sections and for the necessary general information the reader is referred to the guide book for Excursion B3.

ANNOTATED GUIDE.

Iroquois Beach.

Miles and Kilometres.

0. m. 0. km. **Toronto** Alt. 254 ft. 77.2 m.

On leaving the city, the railway traverses a flat area covered with post-glacial sands showing evidence of wind action. At Lambton, the shore of the post-glacial Lake Iroquois is visible to the north, where excavations have been made in the characteristic gravel bars of the ancient beach.

6.7 m. 10.7 km. **Lambton** Alt. 399 ft. 121.3 m.

On crossing the Humber river, good exposures of the Lorraine shales may be seen in the scarped banks of the stream. The Humbervale quarry near here has yielded many excellent examples of the large trilobite, *Isotelus maximus*, Locke. Further exposures of the Lorraine shales occur in the valley of Mimico river a short distance beyond the Humber.

14.4 m. 23 km. **Cooksville** Alt. 391 ft. 118.8 m.

At this point the railway approaches so close to the Iroquois beach that exposures of the gravel bars may be seen from the train. Just beyond Cooksville, the beach is ascended and a more rolling aspect is presented by the surface of the country owing to less modification of the glacial accumulations by post-glacial agencies.

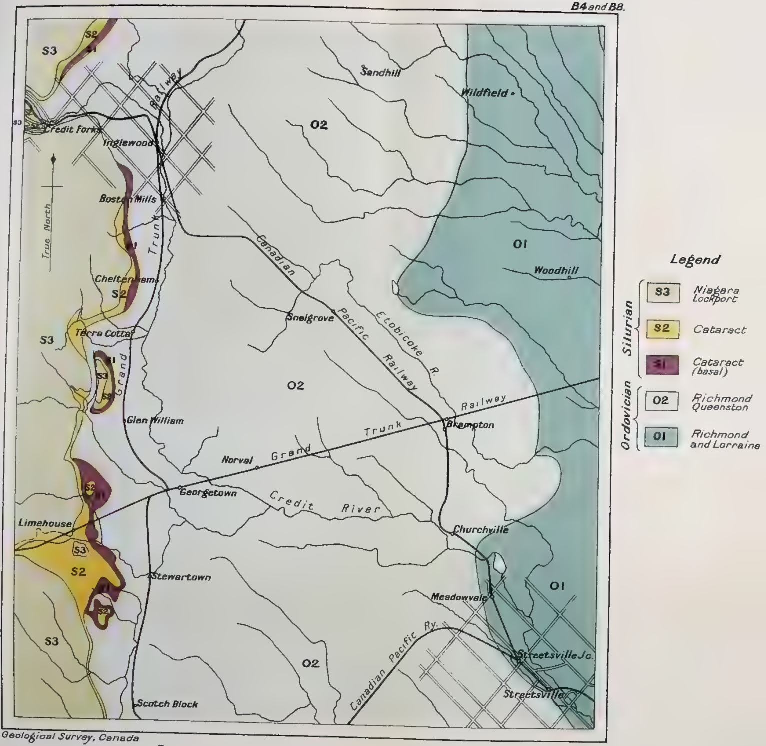
Guide Books Nos. 6 and 7

are published by the Bureau of Mines, Toronto, Ontario. The contents of these are as follows:

GUIDE BOOK No. 6.

GUIDE BOOK No. 7.

B4 and B8.



Geological Survey, Canada

Route map between **Streetsville** and **Credit Forks**

Miles
1 0 2 4 6
Kilometres
1 0 2 4 6 8

Lorraine and Richmond Formations at Streetsville.

Miles and Kilometres.

20.8 m. 33.3 km. **Streetsville** Alt. 500 ft. 152 m.

In the valley of the Credit river at Streetsville, Lorraine shales are overlain by fossiliferous strata of the Richmond formation. To the west of Streetsville this marine type of Richmond, in its turn, is covered by the red unfossiliferous shales of the Queenston member of

Niagara cuesta at the Forks of the Credit.

the Richmond. While this member is entirely without organic remains in the southern part of the province, it reveals a distinct Richmond fauna at points farther north. Beyond Streetsville the ascent is gradual but continuous. Little of interest is to be observed until

Miles and Kilometres.

the vicinity of Cheltenham is reached when the Niagara cuesta comes into view.

41.3 m. 66 km. **Inglewood** Alt. 896 ft. 272.4 m. At Inglewood the red Richmond shales are exposed in undulating hills which are surmounted by the sharp escarpment of the Niagara cuesta, topped by the heavy beds of the Lockport dolomite.

45.5 m. 72.8 km. **Forks of Credit** Alt. 1,076 ft. 328 m. On crossing the high bridge over the Belfontain or west branch of the Credit river, a fine view may be obtained of the face of the cuesta and of the valley of the west branch.

48.2 m. 77.1 km. **Cataract** Alt. 1,313 ft. 399 m. The sections at Cataract and at Credit Forks are indicated below:

	Cataract		Credit Forks.	
	Feet.	Metres.	Feet.	Metres.
1. Lockport dolomite....	30–35	9–10	100	30
Talus (covered)..................			20–30	6–9
2. Cataract shales with green band at top...	65–70	20–22	35–45	11–14
3. Cataract limestones....	25	7.6	23	7
4. Cataract sandstones...	16.5	5	18	5.5
5. Red Queenston shales.	30+	9+	175	53.2

Cataract Section.

1. A short distance south of Cataract Junction and a few feet above the line of railway to Elora there may be seen an excellent example of post-glacial conglomerate marking the position of a lake beach or river bank. Near this point also Lockport dolomite may be seen resting upon the upper green shale of the Cataract; in this locality only has the actual contact between the two formations been observed in the Credit region.

2. Cataract shales are well exposed on the embankment between the main line of the railway and the branch

The "Cataract" falls over Cataract limestone and sandstone near Cataract Junction, Ontario.

to Elora. The upper part shows a bright red layer, rich in *Helopora fragilis*, beneath which lie grey shales with an increasing number of thin calcareous bands towards the bottom. The fossils of the shale are essentially the same as those in the underlying limestones, but differences in relative abundance are quite marked in the case of certain species.

3. The limestone portion of the formation is well shown along the disused road from Cataract Junction to Credit Forks. This member consists mostly of thin-bedded limestones, but it also contains many bands of interbedded shale. A narrow but persistent layer of shale, about 15 feet (4·5 m.) above the base of the formation, contains a characteristic species of *Whitfieldella*. Most of the fossils of the formation are common to both the shale and the limestone, but there is a difference in the abundance of some species, for example, *Helopora fragilis* is much more common in the shale. The following species occur most frequently:—

Hydrozoa—
- Clathrodictyon vesiculosum *Nicholson.*

Corals—
- Favosites niagarensis *Hall.*
- Zaphrentis bilateralis *Hall.*

Bryozoa—
- Callopora magnopora *Foerste.*
- Helopora fragilis *Hall.*
- Homotrypa confluens *Foerste.*
- Pachydictya crassa (*Hall*).
- Phænopora explanata *Hall.*
- Phænopora ensiformis *Hall.*
- Phænopora punctata *Nichalson and Hinde.*
- Phylloporina angulata *Hall.*
- Rhinopora verrucosa *Hall.*

Brachiopoda—
- Anoplotheca planoconvexa (*Hall*).
- Atrypa cf. marginalis (*Dalman*).
- Atrypa reticularis (*Linnæus*), (rare and doubtful).
- Atrypa *sp. nov.* (numerous and typical).
- Camarotoechia neglecta (*Hall*).
- Dalmanella elegantula (*Dalman*).
- Hebertella fausta *Foerste.*

Lower Cataract limestone with Whitfieldella zone indicated, near Cataract Junction, Ontario.

Leptæna rhomboidalis (*Wilckens*).
Orthis flabellites *Foerste*.
Orthis cf. davidsoni *de Verneuil*
Platystrophia biforata (*Schlotheim*).
Rhipidomella hybrida (*Sowerby*).
Rhipidomella cf. circulus (*Hall*).
Schuchertella cf. subplana (*Conrad*).
Whitfieldella sp.

Trilobita—
Acidaspis sp.
Calymmene niagarensis *Hall*.
Encrinurus cf. punctatus *Wahlenberg*.
Encrinurus sp.

In addition to the above there is a considerable number of forms of doubtful determination, including several gastropods related to *Eotomaria*, *Loxonema*, *Trochonema* and *Platyostoma*, also a large species of *Orthoceras*.

4. The basal sandstone of the Cataract formation may be seen beneath the limestones a short distance along the road. A few fossils may be observed on the surface of some of the sandstone slabs, but they are all of very doubtful determination. Gastropods and pelecypods are by far the most abundant.

5. The underlying red shales o the Richmond, destitute of fossils, may be observed in the bed of the creek.

Credit Forks Section.

The line of old quarries which extends along the north side of the ravine of the Belfontain branch affords an excellent opportunity for collecting Cataract fossils. It is interesting to note that the narrow *Whitfieldella* zone referred to in the section at Cataract may also be recognized here.

The basal Cataract sandstone, at this point, was quarried in large quantities formerly, but the increasing overburden has compelled the cessation of operations. A large proportion of both the grey and he brown sandstone used for building purposes in Toronto has been obtained from these quarries.

In the angle between the Belfontain branch and the main river, the escarpment is higher and presents a more complete section, including the Lockport dolomite. This locality is less favourable for collecting than those already referred to, but it is instructive in that it proves the complete absence of both the Rochester shale and the Clinton beds which are exposed on the face of the cuesta at Grimsby and which also occur in the Niagara gorge.

The Lockport dolomite furnishes but few fossils, among which may be mentioned obscure lithistid sponges and indeterminable stromatoporoids. Besides these, the following corals may be obtained:

Alveolites *sp.*
Favosites niagarensis *Hall.*
Halysites catenulatus *Linnæus.*
Syringopora cf. tenella *Rominger.*

The ascent to he top of the cliff is somewhat difficult, but the view well repays the effort.

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EXCURSION B 7.

ORDOVICIAN SECTION ON CREDIT RIVER NEAR STREETSVILLE, ONTARIO.

BY

W. A. PARKS.

CONTENTS.

INTRODUCTION.

The upper Ordovician strata of North America occur in formations of so variable a character in different localities that their exact correlation is a matter of difficulty. The practice is now becoming general to embrace the whole series in the term Cincinnatian and to recognize the following formations:

Richmond,
Lorraine,
Eden,
Utica,
Collingwood.

The Richmond is a widespread and highly fossiliferous formation, which has been divided into several members in the Cincinnati area. The Lorraine formation is less well defined, particularly in the Streetsville section, but it seems advisable to retain the name rather than to add to the large number of local formational names.

The Richmond, as exposed in Ontario, consists of a series of marine limestones and shales, and a great thickness of red shales with some green bands and an occasional bed of limestone. The marine type is best exposed in the Manitoulin islands, whence it may be traced with gradually diminishing thickness to the vicinity of Streetsville. The red Richmond shales (Queenston formation) are of great thickness at Niagara and Grimsby, where they are unfossiliferous and rest directly on the Lorraine. Northward, the formation diminishes in thickness, overlies the marine type and carries fossils characteristic of the Richmond at Collingwood on Georgian bay.

ANNOTATED GUIDE.

Miles and Kilometres.	
0 m. 0 km.	**Toronto.**—Alt. 254 ft. (77.4 m.)
21.7 m. 34.7 km.	**Streetsville Junction.**—Alt. 549 ft. (107 m. A general account of the country along the line of the rai way between Toronto and Streetsville is given in he guide to Excursion B4.

RICHMOND AND LORRAINE FORMATIONS.

The Cincinnatian strata exposed in the vicinity of Streetsville consist of the upper red unfossiliferous shales of the Queenston division of the Richmond, the grey shales and limestones with intercalated coral reefs of the marine Richmond, and the lower arenaceous limestones and shales of the Lorraine formation.

In the valley of the Credit river above the railway bridge, the sha'es and limestones of the marine R'chmond yield an abundant fauna. The lower part of the river valley shows the underlying Lorraine shales and arenaceous limestones of increasing thickness as the river is descended.

Anticline in Richmond strata, Streetsville, Ontario.

Richmond Formation.

The red Richmond shales (Queenston) are not exposed in the valley, but they may be seen in the vicinity. The

different beds of the marine Richmond and the Lorraine are not very persistent; in consequence, it is somewhat difficult to correlate the strata of different exposures. The most continuous layer is a heavy bed of limestone with numerous bryozoa which lies near the base of the Richmond.

A cliff of about 25 feet (7·6 m.) of limestone and shale is presented by the scarped bank of the river near the bridge to the northward of Streetsville Junction. The lower portion only is actually exposed and shows the heavy bryozoan layer of about two feet in thickness. Beneath this are thin-bedded limestones and shales, which may belong to the Richmond or to the underlying Lorraine. This is one of the best localities for collecting the typical stromatoporoids and corals:

Stromatocerium huronense *Billings*.
Columnaria alveolata *Goldfuss*.
Columnaria calicina (*Nicholson*).
Streptelasma rusticum (*Billings*).
Tetradium minus *Safford*.

Just below this point an interesting minor anticline is shown: the heavy bryozoan layer forms the surface rock, but it is covered by three feet of boulder clay containing pebbles and also corals and stromatoporoids of the local formation. The northeast side shows glacial grooving and polishing, but the southwest side is much less affected by the passage of the glacier.

The upper limestones, shales and coral reefs are excellently exposed at several points on the west side of the river above the bridge. Besides the stromatoporoids and corals an abundant fauna is presented, of which the following are the more common species:—

Callopora *sp*.
Prasopora *cf*. hospital s (*Nicholson*).
Rhombotrypa quadrata (*Rominger*).

Catazyga headi (*Billings*).
Hebertella occidentalis (*Hall*).
Platystrophia biforata (*Schlotheim*).
Platystrophia laticosta (*Meek*).
Platystrophia clarksvillensis *Foerste*.

Rafinesquina *cf.* alternata (*Emmons*).
Strophomena planumbona *Hall*, S. rugosa *Blainville.*
Zygospira modesta *Hall.*

Cyclonema bilix *Conrad.*
Lophosira bowdeni (*Safford*).
Lophospira *sp. nov.*
Oxydiscus *sp.*
Schizolopha tropidophora (*Meek*).
Schizolopha moorei *Ulrich.*

Byssonychia grandis *Ulrich.*
Byssonychia radiata (*Hall*).
Byssonychia richmondensis *Ulrich.*
Cymatonota typicalis *Ulrich.*
Modiolopsis concentrica *Hall and Whitfield.*
Modiolopsis cf. versaillensis *Miller.*
Opisthoptera casei (*Meek and Worthen*).
Pterinea demissa (*Conrad*).

Lorraine Formation.

Below the point first described the slant of the river bed causes an increasing thickness of the underlying Lorraine to be revealed. Excellent exposures are presented near the bridge on the road between Streetsville and Streetsville Junction, and also immediately above the railway bridge. The section at the former point is as follows:—

Richmond—

1.	Corralline limestones and shales.....	18 ft.	5·4m.
2.	Grey, thin-bedded limestone and shale	3 ft.	·9 m.
3.	Compact bryozoan limestone........	1·6 ft.	·35 m.

Lorraine—

4.	Grey shale and thin-bedded limestone	3 ft.	·9 m.
5.	Sandstone........................	4 in.	10 cm.

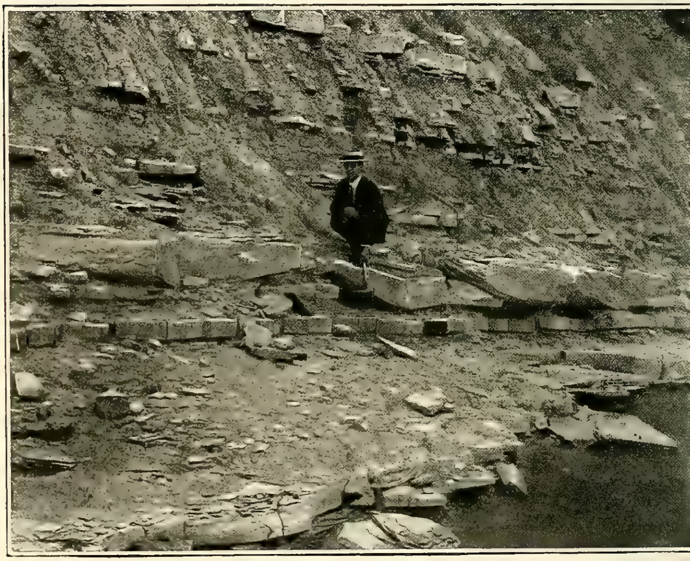
Nos. 1 and 3 contain the typical gastropod, brachiopod and pelecypod fauna.

No. 2 is characterized by the presence of *Byssonychia richmondensis*, Ulrich.

No. 4 contains scarcely any organic remains.

No. 5 is not richly fossiliferous, but it presents examples of *Rafinesquina alternata* (Emmons), *Opisthoptera* sp. and *Modiolopsis concentrica*, Hall and Whitfield.

Near the railway bridge the cliff presents a face of about 31 feet (9·4 m.). The lower 17 feet (5·2 m.) consist of sandstones and shales with obscure and fragmentary fossils: these beds, in whole or in part, are to be referred



Lorraine sandstone and shales, Credit river near Streetsville, Ontario.

to the Lorraine. The upper 14 feet (4·2 m.) consist of limestone and shale with brachiopods and bryozoa typical of the Richmond. The coral and stromatoporoid zone does not appear at this point, nor is it encountered farther down the river.

On the east side of the stream, about a half-mile below the railway bridge, a cliff of 25 feet (7·6 m.) in height presents exposures of Lorraine limestones, shales and sandstones. Some interesting features of cross bedding

and "pillow structure" in sandstone, with contemporaneous erosion of the underlying beds, are to be seen at different horizons in the exposures.

"Pillow" sandstone with contemporaneous erosion in Lorraine beds, Streetsville, Ontario.

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See also the literature cited for the Manitoulin islands, Excursion C-5.

EXCURSION B 9.

ALGONQUIN BEACH, GLACIAL PHENOMENA AND LOWVILLE (ORDOVICIAN) LIMESTONE IN LAKE SIMCOE DISTRICT, ONTARIO.

BY

W. A. Johnston.

CONTENTS.

INTRODUCTION.

The excursion will proceed by Grand Trunk Railway from Toronto to the town of Orillia, which is situated near the narrows between Lakes Couchiching and Simcoe and distant from Toronto in a northerly direction about 85 miles (136.8 km.).

En route, after reaching the Lake Simcoe basin, the Algonquin beach may be seen from the train at several points along the railway. After a closer inspection of the beach at the town of Orillia, a trip will be made by motor to the Longford quarries on Lake St. John about 8 miles (12.9 km.) in a northeasterly direction from Orillia, where a good section may be seen of the Lowville (Birdseye) limestone with basal series of shales, sandstone, etc., resting unconformably on the Pre-Cambrian crystalline rocks. Returning from Longford along the Monck road about 7 miles (11.3 km.) from Orillia, a section may be seen shewing a glacially transported, large boulder or mass of bedded Lowville limestone underlain by till.

The Algonquin beach is well developed in the Lake Simcoe district, where it forms a record of the abandoned shoreline of the immense body of water which occupied the Huron and Michigan basins at the close of Glacial time. In this district, as well as in the northern portions of the Huron and Michigan basins, the beach has an upward tilt towards the northeast. Around the southern ends of Lakes Huron and Michigan, the beach becomes horizontal at an altitude of about 600 feet (182.9 m.) and maintains that height over a considerable area [**1**]. Hence it is supposed that the water of Lake Algonquin stood at this altitude viz. 600 feet (182.9 m.) above sea level.

The lowest point reached by the beach in the Lake Simcoe district is in the valley of Holland river about 15 miles (24.1 km.), south of the extreme head of Lake Simcoe, where the beach has an altitude of 724 feet (220.6 m.), or only 6 feet above Lake Simcoe. It gradually rises to a point about 6 miles (9.6 km.) northwest of Orillia where it has an altitude of 883 feet (269.2 m.), the highest altitude attained by the beach on the west side of Lake Simcoe basin.

About 20 miles (32.2 km.) east of Orillia, near the village of Kirkfield, where for a time the waters of Lake Algonquin discharged eastward into the valley now occu-

Boulder-strewn terrace and bluff of Algonquin beach near Shanty Bay, Ontario.

pied by the Trent chain of lakes and rivers, the beach has an altitude of 883 feet (269.2 m.) and 15 miles (24.2 km.) farther north rises to 925 feet (282.0 m.). Northward from the latter point, on account of the rough and comparatively little drift-covered surface of the country, the beach is difficult to follow and although a strong beach, supposed to represent the Algonquin, has been found at a number of points as far northward as the town of North Bay, sufficient data have not been collected to enable definite correlations to be made.

The maximum tilt rate of the beach in the Lake Simcoe district is in a direction N. 21° E., and the rate increases from 2.3 feet (.7 m.) per mile in the southern portion to nearly 6 feet (1.8 m.) in the northern portion. Lakes Simcoe and Couchiching, and a number of smaller lakes to the east, occupy shallow basins which rarely exceed 100 feet (30.5 m.) in depth, and evidently owe their present existence as lakes to the upward tilting of the land towards the north. Were the land depressed to the relative altitude which it had when the Algonquin beach was made the present outlet of Lake Couchiching, for example, would be about 175 feet (53.3 m.) lower.

North and east of Lake Simcoe, the drift is relatively thin, but in the district to the west and southwest of the lake the drift becomes much thicker, and no exposures of solid rocks are known to occur. Well borings made in this district show the drift deposits to have a thickness of at least 375 feet (114.3 m.), and as the drift hills rise to an altitude of 200 to 300 feet (61 to 91 m.) above the valleys in which the borings were made it is possible that the drift has in places a much greater thickness.

Numerous sections in the drift show two till sheets separated by stratified sands and gravels. The uppermost or last till sheet consists of two distinct portions, an upper part, often with a well bedded character and composed of a loose sandy till, and a lower portion consisting of a more compact, sandy clay till with little or no trace of stratification. Associated with the former and generally crowning the summits of hills and ridges are well stratified deposits of sands and gravels, which often bear a semblance to beach ridges. Their mode of origin is not clear, but they do not appear to be referable to wave built features.

Over a considerable part of the district the till of the lower portion of the last till sheet merely forms a thin

veneer which conforms to the contour of the underlying stratified sands, gravels and clays. These interglacial or interstadial beds are of considerable thickness, and appear to have suffered erosion for a long period of time prior to the deposition of the last till sheet, during which time broad valleys were carved in the earlier deposits.

The till of the lower till sheet is generally only exposed in the beds of streams, where it is seen to be composed of hard, compact, sandy clay till, without stratification, containing numerous well polished and striated cobbles and boulders. This till withstands erosion remarkably well, and where trenched by streams is sometimes seen to stand up in vertical sections or to form rock-like ledges which cause rapids.

Well borings in the district show the presence of a still lower till sheet, but this till is not known to be exposed in any sections.

Extensive deposits of stratified sands, gravels and lake clays also occur in the district below the level of the Algonquin beach.

So far as known, no fossils have been obtained in this district from the sands and gravels of the Algonquin beach or from the interglacial beds. Fresh water shells are, however, abundant in the sands and clays of the valley of Nottawasaga river, but at no great height above Georgian bay.

On the northeastern side of Lake Simcoe an area of drumlins of the long narrow type is well developed. The drumlins are generally composed of a sandy unstratified till or boulder clay which appears to be almost entirely derived from the last till sheet. The longer axes of the drumlins coincide with the direction of glaciation as shown by striae on adjacent rock surfaces. The general direction of glaciation throughout the district is towards the southwest, and, as a rule, wherever the surface of the rock has been protected from weathering, striae are abundant and well preserved.

Over a considerable portion of the district around the west and south sides of Lake Simcoe, imperfect drumlin forms are developed, and in fact the greater part of the region appears to have been subjected to some degree of ice moulding beneath the overriding ice of the last sheet. Accordingly terminal moraines or ice marginal deposits are rarely well seen in the district. Some parts of the area,

notably the relatively high upland tract lying to the south of the town of Barrie, are gently undulating, nearly flat, till plains characterized by numerous small depressions. The most notable exception to the prevailing "drumlinized" and till plain surface is the range of hills which lies about midway between the towns of Barrie and Orillia and from 7 to 10 miles (11 to 16 km.) west of the lake. These hills, the highest of which rises to an altitude of nearly 600 feet (182.9 m.) above Lake Simcoe, are composed, in greater part, of a loose sandy till partially stratified. They are, in part morainic in character and appear to have been formed during the retreat of the last ice sheet.

The greater portion of the area of Lake Simcoe district is underlain by limestones of the Trenton, Black River and Lowville formations (Ordovician), the last of which rests unconformably on Pre-Cambrian crystalline rocks. The limestones dip gently towards the southwest at a rate generally not exceeding 25 feet (7.6 m.) per mile, and have an estimated maximum thickness in the district of 550 feet (167.7 m.). Eastward from the lake, the limestones are often well exposed and form a rock divide between the waters of Lake Simcoe and Trent valley.

The northern portion of the district, including the area surrounding the lower end of Lake Couchiching, is occupied by Pre-Cambrian rocks. Near the contact of the limestones with the Pre-Cambrian rocks, an escarpment is generally developed, and fronting the escarpment, and often at a considerable distance from it, are numerous outliers of limestone, showing that the limestone, at one time, extended far over the Pre-Cambrian rocks to the north.

ANNOTATED GUIDE.

Miles and Kilometres.

0 m.
0 km.

Toronto, (Union Station). Alt. 254.0 feet (77.4 m.).

14.0 m.
22.5 km.

Thornhill.—Alt. 635 feet (193.5 m.).

Leaving Toronto the railway passes northward over a series of drift hills and ridges locally known as Oak Ridges which are, in part, morainic in character, and extend for

Miles and Kilometres.

over 100 miles (161 km.) in a general east and west direction, roughly parallel to Lake Ontario and a few miles north of the lake. The drift in the hills, which rise to an altitude of 600 to 900 feet (182.9 m. to 274.3 m.) above Lake Ontario, is known to be of considerable thickness. At Thornhill, 14 miles (22.5 km.) north of Toronto, a well boring penetrated 640 feet (195.1 m.) of drift before reaching the Trenton limestone which was the first solid rock formation encountered. The boring continued through 585 feet (178.3 m.) of the Trenton, Black River and Lowville formations to the Pre-Cambrian.

27.2 m. 43.8 km. **Chesley.** Alt. 980 feet (298.7 m.). One mile south of Chesley station, the summit on the line of railway is passed at an altitude of 1,002 feet (305.4 m.). Going northward, the railway rapidly descends into a broad valley which extends, nearly at the level of Lake Simcoe (low water 718 feet, 218.9 m.), for some 20 miles (32.2 km.) southward from the head of the lake. This valley was occupied by a deep embayment of Lake Algonquin, the shoreline of which is well marked on both sides of the valley. Near the village of Sch mberg, at a point about 15 miles (24.1 km.) south of the extreme head of the lake, the Algonquin beach has an altitude of 724 feet (220.7 m.), only 6 feet (1.8 m.) above the level of Lake Simcoe.

41.2 m. 66.3 km. **Bradford.** Alt. 724 feet (220.7 m.) At the town of Bradford, a well boring penetrated 330 feet (100.6 m.) of drift deposits before reaching the Trenton limestone. The terrace and bluff of the Algonquin beach near the station, has an altitude of 749.0 feet (228.3 m.). At Lefroy 10 miles (16.1 km.) further north, the beach which may be seen on the west side of the railway near the station, rises to 774 feet (235.9 m.).

64.0 m. 103.0 km. **Barrie.** Alt. 726 feet (221.3 m.). The town of Barrie is situated at the head of Kempenfeldt bay, an arm of Lake Simcoe.

Miles and Kilometres.

A broad flat-bottomed valley extends westward for a number of miles from the head of the bay, and is floored by a considerable thickness of sands and gravels derived from the Algonquin beach, which has an altitude, at the town of Barrie, of 785 feet (239.6 m.). The sides of the valley are composed of drift, and rise steeply to an altitude of over 200 feet (60.9 m.) above the valley bottom. The record of a well boring, made near the town of Barrie, shows the surface deposits to have a thickness of 335 feet (102.1 m.) below the level of Lake Simcoe at which point the Trenton limestone was struck. The boring continued through 200 feet (60.9 m.) of the limestones of the Trenton, Black River and Lowville formations to the Pre-Cambrian. The deep borings mentioned above as having been made in the drift deposits at Thornhill, Bradford and Barrie, together with several others made in the district, confirm the existence of a deeply drift-filled pre-glacial valley connecting the basins occupied by Georgian bay and Lake Ontario, the probable existence of which was pointed out by J. W. Spencer. [**4.**]

Between the towns of Barrie and Orillia, a distance of about 25 miles (40.3 km.), the Algonquin beach is well developed and can be followed with nearly perfect continuity all the way. Throughout the greater part of the distance, the railway follows along almost at the same altitude as the bea h. At Hawkestone, about 14 mlies (22.5 km.) north of Barrie, the bluff and boulder-strewn terrace of the ancient shoreline may be seen a short distance west of the station at an altitude of 821 feet (250.2 m.).

86.0 m. 138.5 km. **Orillia.** Alt. 724 feet (320.7 m.).

GEOLOGY OF THE DISTRICT AROUND ORILLIA.

General.

The town of Orillia is situated near the narrows between Lakes Couchiching and Simcoe, and is built in part on a sandy terrace just below the Algonquin beach. In the town, along the Coldwater road, which is the main road leading westward, the cut bluff and boulder pavement of the beach may be well seen. A mile west of the town, a gravel pit shows a section across a great barrier beach having an altitude of 853 feet (260·0 m.) or 135 feet (41·2 m.) above Lake Simcoe.

North and east of Orillia the drift is relatively thin, but west and southwest it becomes quite thick. A well boring made in the town itself shows the surface deposits to have a thickness of 170 feet (51·8 m.). A half-mile north of the station at Orillia, a cutting on the Canadian Pacific railway shows well stratified sand overlain by till, and a half-mile east of the station a cutting affords a section through a drumlin-like ridge composed of boulder clay. Northeast and east of Orillia an area of small drumlins and drumlin-like ridges is developed. The drumlins are generally long and narrow, and range in height from a maximum of 60 feet (18·2 m.) down to 10 feet (3 m.) or even less, and vary in length from two miles to one quarter mile or less. The longer axes of the drumlins are nearly parallel and coincide with the direction of glaciation, which was towards the southwest. The drumlins are generally composed of sandy boulder clay, showing little or no stratification. Occasionally they are seen to be, in part, composed of coarse sand and gravel partially stratified, with numerous boulders and cobble stones. At the north end of one of these drumlins one mile (1·6 km.) east of North Mara post office, along Monck road, a section shows a large boulder or mass of bedded Lowville limestone, which is underlain by drift and was evidently glacially transported or shoved so that it now rests at a steep angle on the northern slope of the drumlin. The section is exposed by the face of the limestone having been opened up as a quarry.

No exposures of solid rocks are known to occur in the immediate vicinity of the town of Orillia, but a short

Section showing glacially transported mass of bedded Lowville limestone underlain by till. The base of the shovel marks the contact.

distance to the north and northeast the limestones of the Black River and Lowville formations, which underlie the Trenton limestone and rest unconformably on the Pre-Cambrian rocks, are well exposed and overlap the Pre-Cambrian. The northern end of Lake Couchiching is occupied by the Pre-Cambrian rocks, and near the contact an escarpment is generally developed in the limestone, which affords numerous sections.

Section of the Lowville Formation.

At the Longford quarries on the west side of Lake St. John, about 8 miles (12·9 km.) northeast of Orillia, a good section is exposed of Lowville (Birdseye) limestone with basal series of shales and sandstone or arkose. The eastern and northern sides of the lake are occupied by Pre-Cambrian rocks, but along the western side a limestone escarpment is developed, in the face of which a number of quarries have been opened. The beds dip slightly towards the southwest, and at the north end of the lake overlap the crystalline rocks. Near the contact the beds have a steep dip and appear to be faulted.

The general section of the Lowville formation is as follows:—

1. **Basal series of sandstones, shales, etc.**—The base of the series consists of a few feet of coarse, calcareous sandstone or arkose, which rest unconformably on the Pre-Cambrian crystalline rocks. These beds pass upward into red and green shales with intercalated lenses or thin beds of sandstone, and occasionally thin beds of fine-grained, dove-coloured limestone. The thickness of the series varies, and the beds are frequently absent on the sides and tops of ridges or domes of the crystalline rocks, where the limestones are seen to rest directly on the old floor. The sandstone and shales are best developed in basins between ridges of the crystalline rocks, where they occasionally have a maximum thickness of about 40 feet (12 m.). They are local in character and derivation, and evidently represent the old soil covering of the Pre-Cambrian rocks somewhat sorted, rearranged and recemented, and it seems probable that they represent the initial near-shore deposit of the next succeeding formation.

2. **Lower Lowville (Beatricea beds).**—The red and green shales pass upward into impure magnesian limestones, which on fresh fracture are greenish-grey in colour and weather yellowish brown. They are characterized by numbers of drusy cavities, occasional quartz grains and crystals of pyrite or limonite, and are generally barren of fossils. They are only a few feet in thickness and are followed by 6 to 10 feet (1.8 to 3 m) of fossiliferous blue-grey to dove-coloured limestone characterized by an abundance of a species of Beatricea. These beds somewhat resemble in physical character the typical fine-grained "Birdseye" limestone, but are less compact in texture and weather to a shaly mass. These beds contain a considerable fauna, among which may be mentioned: *Rafinesquina minnesotensis*, *Zygospira recurvirostris*, *Cyrtodonta huronensis*, *Lophospira bicincta*, *Isotelus gigas and Tetradium halysitoides*. They are overlain by 7 to 10 feet (2·1 to 3 m.) of unfossiliferous magnesian limestone very similar to the beds which immediately underlie them,

3. **Upper Lowville (Birdseye) limestone.**—The Beatricea beds are overlain by about 20 feet (6 m.) of fine-grained, even-bedded, dove-coloured limestone, characterized by such fossils as *Phytopsis tubulosum*, *Bathyurus extans*, *Leperditia fabulites*, and in the upper portion by a great abundance of *Tetradium cellulosum*.

The Lowville limestone, which is sometimes included in the Black River as a sub-formation, is well developed in south central Ontario, and is remarkable for its constant lithological and faunal character not only throughout this district, but as far as Kentucky, Tennessee and Alabama on the south.

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EXCURSION C 5.

GEOLOGY OF SELECTED AREAS ON LAKES ERIE AND HURON IN THE PROVINCE OF ONTARIO.

BY

William A. Parks.

With Sections by C. R. Stauffer, A. F. Foerste, M. Y. Williams and T. L. Walker.

CONTENTS.

INTRODUCTION.

Physical Features.

The portion of Southern Ontario which lies west of a line from Georgian bay to Toronto is known as the Western Peninsula. The whole of this region is embraced in the coastal plain of Palæozoic age which was laid down on the western flank of the continental Pre-Cambrian protaxis. The area is divided into two physiographic units by a more or less abrupt escarpment (Niagara cuesta), which extends from Queenston on the Niagara river to Hamilton at the head of Lake Ontario and thence into the Bruce peninsula between Lake Huron and Georgian bay. East of this escarpment lies the Palæozoic lowland of Eastern Ontario which therefore extends only a short distance into the Western Peninsula and appears as a narrow belt along its eastern side. The western and much greater portion of the peninsula constitutes an upland with an average elevation above the eastern lowland of about 300 feet (91.2 metres).

The southern part of the western upland is remarkably flat as shown by the following elevations along the lines of the chief railways:

—	Elevation at Niagara Falls.		Elevation at Summit.		Elevation at Windsor.	
	Feet.	Met.	Feet.	Met.	Feet.	Met.
Michigan Central Ry.—Niagara Falls to Windsor, 225·75 miles.... (361·2 km.)	585	177·8	815	247·8	580	176·3
Grand Trunk Railway—Niagara Falls to Windsor, 229·35 miles.... (366·9 km.)	573	174·2	1007	306·1	579·4	176·1

A little farther to the north, the maximum elevation on the line of the Grand Trunk railway from Toronto to

Sarnia is 1,248 feet (379.4 m.), while in the county of Grey near Collingwood a maximum elevation of 1,706 feet (518.6 m.) is reached in the Blue mountains.

A heavy mantle of drift covers almost the whole of the area and, in places, attains a remarkable thickness. Post-glacial accumulations in the form of stratified sands and clays are widely distributed and the strand lines of post-glacial lakes are marked by beaches of gravel and sand. These glacial and post-glacial soils are of great fertility and, aided by the southerly latitude, render the Western Peninsula of Ontario one of the finest agricultural sections of Canada.

Glacial striæ with a general southwest trend are to be seen wherever the rock is sufficiently hard to retain them and the exposure to the weather has not been too long.

The rock basin of Lake Ontario, at its deepest point, is 738 feet (224.4 m.) beneath the surface of the lake, and Lake Huron reaches a maximum depth of 750 feet (228.0 m.). On the other hand, Lake Erie is nowhere more than 210 feet (64.0 m.) deep, and its average depth is very much less. The deepest part of Lake Ontario is off its southern shore: this lineal depression is thought to represent the bed of a great pre-glacial river which entered the basin of Lake Ontario from the west and drained a wide area in that direction. The waters of the Lake Huron basin are believed to have entered the Ontario valley by a great river whose course was down the western side of Georgian bay, across the Province of Ontario to a point a little east of Toronto and thence southward to a junction with the river in the Ontario basin. It would appear, therefore, that in pre-glacial times, Lake Erie did not exist and that Lakes Huron and Ontario were either absent or of much restricted area.

The enormous accumulations of drift which choked the above mentioned pre-glacial valleys are responsible, with some later modifications, for the present distribution of land and water in this area. Significant of the recent origin of the present system of drainage, is the fact that the water of streams rising 25 miles (40.0 km.) north of Toronto follows a circuitous path of 700 miles (1126·5 km.) in order to gain access to Lake Ontario. The thousands of islands along the eastern side of Georgian bay likewise attest the recent invasion of the waters of Lake Huron into the Pre-Cambrian oldland of Central Ontario.

Grand Manitoulin island and a number of smaller islands in the northern part of Lake Huron are formed of the same series of Ordovician and Silurian rocks that appear in the Western Peninsula. These islands must therefore be included in a general sketch of the Palæozic formations of the region.

The Palæozoic—Pre-Cambrian contact extends across the Province of Ontario from near Kingston to the head of Georgian bay. Northward from this point it is hidden under the waters of Lake Huron except for its occasional appearance on some of the islands along the east side of Georgian bay and on the islands between Manitoulin and the north shore of Lake Huron.

Geology.

The formations exposed in this district are indicated in the following table:—

Devonian....	Genessee (Chemung.) Hamilton. Onondaga. Oriskany.
Silurian.....	Monroe. Salina. Guelph. Niagara. Clinton. Medina. Cataract.
Ordovician..	Richmond. Lorraine Eden. Utica. Collingwood. Trenton. Black River. Lowville.

The brow of the Niagara cuesta is marked throughout its whole extent by a heavy bedded dolomitic limestone—he Lockport dolomite. The more or less precipitous face

of the escarpment affords many excellent exposures of the formations beneath; in the Niagara gorge the section extends down to the Richmond, and in Manitoulin island to the Collingwood. The lower Ordovician formations are best seen on the small islands north of Manitoulin. The western peninsula affords numerous exposures of the upper Silurian formations and the different members of the Devonian series, but none of these are to be seen in the Manitoulin islands.

The following list indicates briefly the points at which the various formations may be most conveniently studied:

Chemung	Kettle point.
Hamilton	Thedford.
Onondaga	Port Colborne, Pelee island.
Monroe	Amherstburg.
Niagara	Niagara, Manitowaning, Collingwood.
Medina and Clinton	Niagara.
Cataract	Manitoulin island, Collingwood, Niagara.
Lorraine and Richmond	Clay cliff, Manitoulin island. Near Collingwood.
Collingwood and Utica	Craigleith.
Trenton	Shore near Collingwood.
Lowville, Black River and Trenton	Islands north of Manitoulin.

The relationship of the Cataract, Medina and Clinton formations may be studied to better advantage at Hamilton and at the forks of the Credit. (See Excursions B 3 and B 4). An opportunity to examine the Guelph exposures is presented by Excursion A12.

The crystalline Pre-Cambrian rocks of the continental protaxis occupy the whole of the eastern shore of Georgian bay and extend along the north shore of Lake Huron. The subdivisions of the Pre-Cambrian recognized within the area covered by the excursion are, in descending order, as below:—

Huronian.
Laurentian.
Grenville.

Exposures of the Huronian are to be seen along the north shore and on numerous islands westward from the vicinity of Killarney. Bell has mapped the rocks of this age in two series—a lower series, "*sericite, chlorite, hornblende, and arkose-schists, clay slates, greywackes, quartzites bands and dolomites*", and an upper series consisting of *quartzites*.

The quartzites form prominent ridges with a general east and west direction which constitute a striking physiographic feature of this part of the north shore. Near Killarney an altitude of 1385 feet (421 m.) is attained and even greater heights are reached a short distance inland. Both series of the Huronian are invaded by numerous masses of diabase, diorite and granite which afford interesting contact phenomena.

The gneisses and gneissoid granites of the Laurentian form most of the shore of Georgian bay from Killarney to the Palæozoic contact at its southern end. The continuity of this series is interrupted, however, near Parry Sound by a band of Grenville rocks with which some interesting eruptives are asssociated.

ANNOTATED GUIDE.

Lake Ontario—Alt. 244·99 ft.; 74·37 m. Lake Ontario is 193 miles (310·8 km.) long, 53 miles (85·3 km.) wide and 7,450 square miles (19,310 sq. km.) in area. The mean elevation is 244·99 feet (74·37 m.) and the maximum depth 738 feet (224·9 km.). The north shore of the lake, in the vicinity of Toronto, consists largely of sand, but bold cliffs of glacial material face the lake to the eastward of the city at Scarborough Heights, where one of the finest glacial sections in the world is presented. (See Guide Book to Excursion B-2). Toronto island has been formed by debris swept westward from these heights by a current which sets along the north shore.

To the west of the city a few exposures of Lorraine shales occur at the water level. The red shales of the

Richmond formation underlie the sands and gravels around the western end of the lake and continue to the Niagara river and beyond into the State of New York. Exposures are not to be observed at the water level, but numerous outcrops occur a short distance inland.

A few miles inland from the south shore of the lake the Niagara cuesta rises to a height of about 350 feet (106·7 m.) above the water. The strip of land between the cuesta and the lake, extending from the Niagara river to Hamilton is the finest fruit-growing district in Canada. Grapes and peaches of excellent quality are produced in abundance, as well as many other kinds of fruit. Sixty-six varieties of grapes are raised in the district.

Port Dalhousie—Alt. 250 ft.; 76 m. Port Dalhousie was an important ship-building centre before the advent of railways in Ontario. At the present time it is best known as the northern portal of the Welland Canal, which connects Lakes Erie and Ontario. Two canals have been constructed along this route by the Canadian Government. The first canal, commonly referred to as the "old canal," has a depth of 10 feet 3 inches (3·07 m.); it was begun in 1824 and completed in 1833. Construction work on the new canal began in 1872 and was completed in 1887. The total length is 26·75 miles (43 km.), and the total rise, or lockage, is 326·75 feet (99·6 m.). There are 26 locks, each of which is 270 feet (82·3 m.) long, 45 feet (13·7 m.) wide and 14 feet (4·2 m.) deep.

St. Catharines—Alt. 346 ft.; 105·18 m. Leaving Port Dalhousie, the electric railway crosses the fruit lands to St. Catharines. The ascent is gradual over post-glacial accumulations, which may be seen to the west of the harbour at Port Dalhousie. About half-way, the line of the old canal is crossed.

St. Catharines is noted for its paper and rubber manufactories, but more particularly as the centre of the fruit industry. A saline spring at St. Catharines contains per gallon of water the following solids:

$NaCl$	2200·9370 grains
$CaCl_2$	1104·4100
$MgCl_2$	284·6508

KCl	19·6833 grains
$CaSO_4$	138·5538
$FeCO_3$	3·6470
KI	·0980
$MgBr_2$	·0496

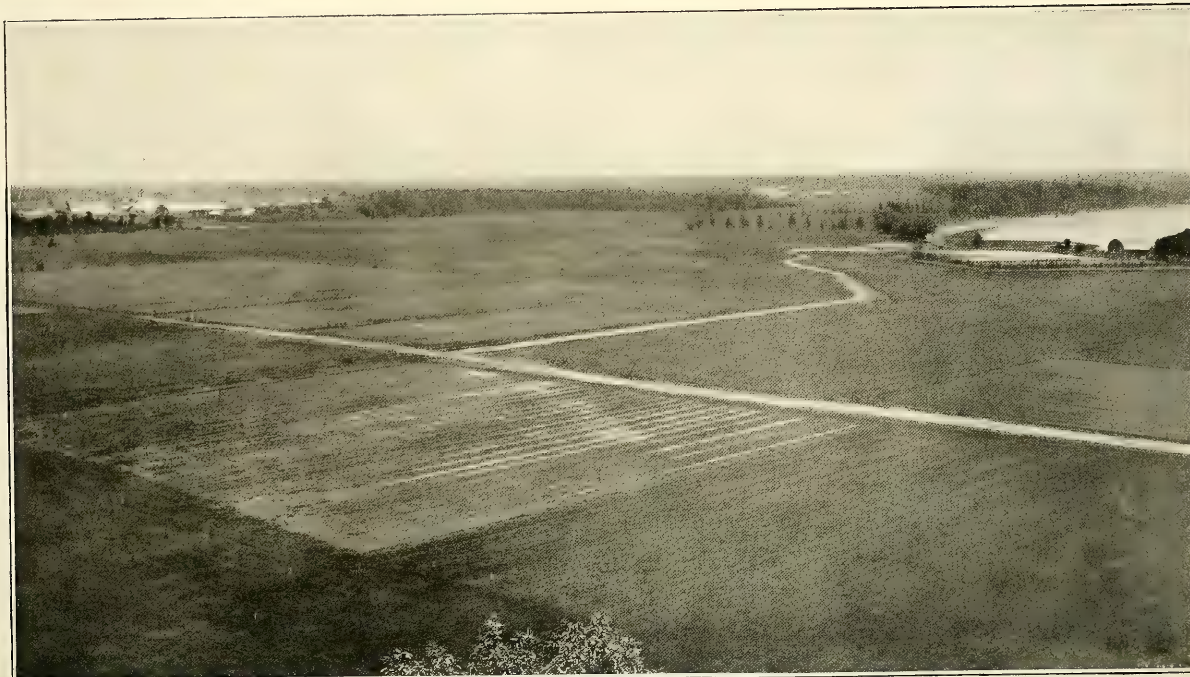
Leaving St. Catharines, the railway begins the ascent ot the Niagara cuesta. No exposures of the Richmond or of the overlying Cataract sandstone, shale and limestone are to be seen, but at Merritton (Alt. 411 feet, 125·2 m.) the white and red mottled sandstone and shale of the Medina formation crops out on the west side of the track.

Thorold—Alt. 595 ft.; 180·8 m. On approaching Thorold, the old canal may be seen to the west and the new canal to the east. The dolomitic limestone of the Niagara (Lockport) formation is exposed above the new canal and may be seen in the distance. From this point a large amount of excellent building stone has been quarried. The metallurgical works of the Coniagas Reduction Company in which a large amount of Cobalt ore is treated are situated near Thorold.

Niagara Falls—Alt. 557 ft.; 169·3 m. Between Thorold and Niarara Falls, the railway continues on the upland and, in places, is close enough to the brow to afford an outlook over the lowland to the north. The Pleistocene deposits are of post-glacial character, and the district is better adapted to general agriculture than to fruit raising. A full account of the geology of Niagara Falls and the surrounding country is given in the guide to Excursions A4 and B1; to these the reader is referred.

From Thorold to Port Colborne 18·8 miles (29·1 km.) the country is flat or slightly sloping to Lake Erie. About 15 miles (24·1 km.) from Thorold a peat bog covering six or seven square miles is crossed. Beyond this is an exposure of unfossilife ous shaly limestone, which probably belongs to the Salina formation at the top of the Silurian. The Oriskany sandstone at the base of the Devonian is not exposed, but the Onondaga limestone is represented near Humberstone and continues to the shore of Lake Erie.

Port Colborne—Alt. 583 ft., 177·74 m.



View from the top of Sugar loaf showing lack of relief about Port Colborne.

GEOLOGY OF THE REGION AROUND PORT COLBORNE.

BY

Clinton R. Stauffer.

General Description.

The region about Port Colborne is a nearly level till plain, which was modified by the marginal lakes of the retreating continental glacier. Much of the land to north and west is covered by a great peat bog, which has been utilized to a limited extent in the manufacture of briquettes for fuel. The higher land usually means bed-rock close to the top of the ground, and it is not uncommon to see its smoothed and striated surface in the gutters along the highways and railroad tracks.

The Lake Erie beach, in the vicinity of Port Colborne, is chiefly sand, and the mounds adjacent to it are of the same material, which the wind has heaped into dunes. In most cases the dunes have been rendered stationary by the growth of vegetation, but to the west of the town some of them are in a semi-active state of migration. The points of land (see the accompanying map) projecting into the lake, however, are almost invariably outcrops of Onondaga limestone (Devonian). This rock rarely rises more than a foot or two above the water level, but forms an effective barrier against wave erosion, which elsewhere has been so destructive.

Port Colborne lies within the Ontario gas belt, and several of the wells may be seen in and about the town. The gas is obtained from a stratum of white sandstone within the Medina (Silurian), which is here about 450 feet (137·2) m.) below the surface. The Medina, which is chiefly red shales and sandstones, was seen outcropping along the Niagara gorge, especially at the Whirlpool Rapids and northward. It also outcrops along the escarpment westward to Hamilton.

The general dip of the bed rock of this region is to the south, but it is usually too variable in amount to

Sugar loaf, a stationary sand dune just west of Port Colburne.

A 12 and C 5.

Geological Survey, Canada

Port Colborne

record. Here and there fairly well developed anticlines and synclines appear, while at other places the rock seems to lie nearly flat.

The southern part of the Port Colborne region is underlain by the Onondaga limestone, while the Cobleskill dolomite (Silurian) and the Salina beds (Silurian) occur immediately under the surface deposits to the north. These latter form but meagre outcrops although they are reached by the drill in boring for gas. [**6**] Great heaps of the Silurian rocks, removed during the construction of the Welland canal, may be seen to the northward from the village of Humberstone. These formations include dolomitic beds and shales of varying thicknesses.

The Onondaga was formerly called the Corniferous limestone [**5**] because of the abundance of chert which it contains. While chert is a striking characteristic of this formation in Ontario near the eastern end of Lake Erie, it is rare or absent in the same beds which outcrop along the Detroit river and on the islands to the south. It is a most variable formation in its physical appearance. At the Port Colborne locality its upper portion is a dark bluish to brownish black limestone containing a great quantity of dark coloured chert. Just below this, and sometimes separated by a very sharp line, is a highly calcareous, semi-crystalline limestone filled with corals. This rock grades into beds of less purity, as the lower portion of the formation is approached, while the basal part is a conglomerate [**9**] (shown only in the bottom of the Welland canal) of Silurian pebbles mingled with sand and calcareous mud. The Onondaga limestone is abundantly fossiliferous. Many of the fossils are silicified and stand out in relief with most of the structures preserved as the limestone weathers away under the thin coating of drift. Corals are most plentiful and these are often so numerous as to form true reefs. These coral beds may be traced westward from Fort Erie to Villa Nova—a distance of over 45 miles (72·44 km.) Many of the types described by E. Billings and James Hall, were obtained in the vicinity of Port Colborne.

SECTIONS OF THE ONONDAGA.

The Hogan Quarry. This quarry now abandoned but under the control of the Canadian Portland Cement

Company, is located in the northwestern part of Port Colborne to the west of the interurban track (Port Colborne division of the Niagara, St. Catharines and Toronto Railway) at the crossing of the Grand Trunk switch. Very little quarrying has been done, but quite a large surface has been stripped and this furnishes an ample opportunity for collecting. In general the rock is too hard for successful collecting from the unweathered portions. Corals and stromatoporoids are especially abundant and may be seen studding the exposed surface, while several species of gastropods and a half dozen brachiopods are not uncommon.

Section of the Hogan Quarry.

	Thickness.	
	feet.	metres.
6. Soil and drift..........................	1	·305
5. Hard bluish limestone with rough black chert. Where weathered the chert stands out in relief. These beds are quite fossiliferous and afford good collecting. The top surface is well glaciated at the west end of the quarry.	1·5	·458
4. Dark bluish limestone containing an abundance of silicified compound corals which afford good collecting in the central portion of the quarry.....	1·5	·458
3. Blue limestone with very little chert. The lower half is filled with corals chiefly of the small branching type. Among these *Cladopora labiosa* (Billings) is abundant. In the cracks and crevices of the eastern portion of the quarry some small but very good specimens may be found................	3	·915
2. Blue limestone with some black chert and often with shaly bedding planes. Sometimes the bedding planes are very rough and uneven, chiefly because of the presence of large corals. Crinoid stems of large size are conspicuous but the heads are rare. These beds are shown chiefly in the water hole...	5·83	1·78

	Thickness. feet.	metres.
1. Rather compact blue limestone, with little or no chert, and fossils less abundant. This portion extends to the water level in the lowest hole.....	5	1·52

The fossils found in this quarry are given in the first column on page 53.

The Canadian Portland Cement Company's Quarry. One mile westward from the last place discussed, on the Grand Trunk railroad, is one of the Canadian Portland Cement Company's plants. In the manufacture of their product they use the Onondaga limestone and a post-glacial clay, both obtained nearby. This cement plant has a capacity of 3,500 barrels per day—over one and a quarter million barrels annually. The quarry is located a short distance to the west of the buildings, on a small low anticline, the axis of which runs a little to the north of east. In the quarry proper the beds dip off rather sharply to the north-northwest bringing in the higher beds in that portion of the pit. The best collecting is in the weathered portion of these upper beds, although much depends on the most recent stripping. The more massive beds of the interior and eastern side of the quarry, however, are not lacking in interest, for it is in them that the great masses of coral may be found. The surface of the extreme eastern side is well glaciated.

Section of the Canadian Portland Cement Company's Quarry.

	Thickness. feet.	metres.
6. Soil and drift..........................	3	·915
5. Dark bluish limestone containing much black chert. Weathered surfaces rough and uneven. These layers are sometimes separated from the underlying beds by several inches of shale..	4·5	1·372
4. Somewhat massive, sub-crystalline, blue limestone with a small amount of chert, and corals rather abundant....	3·5	1·067

	Thickness. feet.	metres.
3. An impure blue limestone with little or no chert and a great many corals scattered through it. Bedding planes rough and irregular, often shaly and containing much carbonaceous matter.	2·6	·714
2. A rather massive, sub-crystalline, bluish gray limestone with partings of a greenish shale. This shale is found chiefly in the middle and lower part, and is said by Mr. Pettingill, chief chemist at the cement plant, to have a composition analogous to that of glauconite. The bedding of this mass is often rough and irregu'ar. Corals are abundant and well preserved, but almost impossible to collect. At the east side of the quarry these layers come to the top and show several sets of glacial striae on the exposed surface, the most prominent of which run S. 40° W. These beds vary considerably in thickness, but the full amount here given is exposed along the east side of the quarry. This massive portion of the Onondaga is quite persistent and may be traced eastward into New York state....................	18·5	5·643
1. Massive grey l'mestone, passing downwards into a slaty grey to brown impure limestone. These beds are streaked with semi-crystalline bands in which fossils are more abundant. They extend to the bottom of the water hole at the west side of the quarry............................	10	3·05

The fossils found at this locality are given in the second column of the accompanying table.

The large mound, three-quarters of a mile to the south of the cement plant is Sugar Loaf—a sand dune which is covered with vegetation and therefore stationary. Other dunes a short distance to the west are in a partial state of active migration.

ONONDAGA FOSSILS FROM HOGAN'S QUARRY AND THE CANADIAM PORTLAND CEMENT COMPANY'S QUARRY NEAR PORT COLBORNE.

	Hogan Quarry.					Canadian Portland Cement Co's Quarry.				
	1	2	3	4	5	1	2	3	4	5
Sponges										
Hindia fibrosa (Roemer)								x		
Hydrozoa										
Clathrodictyon cellulosum *Nicholson.*				x		x				
Stromatoporella granulatum *Nicholson*		x	x	x			x			
Stromatoporella (?) tuberculata *Nicholson*			x				x			
Syringostroma nodulata *Nicholson*			x	x						
Corals										
Alveolites confertus *Nicholson*			x							x
Alveolites distans *Nicholson*			x							x
Alveolites ramulosus *Nicholson*			x							x
Aulopora cornuta *Billings*			x							x
Aulopora tubiformis(?) *Goldfuss*										x
Bothrophyllum decorticatum *Billings*		x	x	x	x					x
Bothrophyllum promissum *Hall*										x
Chonostegites clappi *Edwards and Haime*							x			
Cladopora cryptodens (*Billings*)			x							x
Cladopora imbricata *Rominger*										x
Cladopora labiosa (*Billings*)			x	x	x	x	x	x		x
Cladopora pinguis (?) *Rominger*										x
Cladopora pulchra *Rominger*										x
Cystiphyllum vesiculosum *Goldfuss*	x	x	x	x	x	x	x	x	x	x
Eridophyllum verneuilianum *Edwards and Haime*							x			
Favosites basalticus *Goldfuss*		x	x	x	x	x			x	x
Favosites canadensis *Billings*		x	x	x	x		x		x	x
Favosites cervicornis *Edwards and Haime*			x							
Favosites emmonsi *Rominger*	x	x	x	x	x	x	x	x	x	x
Favosites epidermatus *Rominger*			x	x	x					x
Favosites limitaris *Rominger*			x	x	x					x
Favosites radiciformis *Rominger*		x								x
Favosites turbinatus *Billings*	x	x	x	x		x	x		x	x
Favosites winchelli *Rominger*						x	x			

	Hogan Quarry.					Canadian Portland Cement Co's Quarry.				
	1	2	3	4	5	1	2	3	4	5
Heliophyllum corniculum (*Lesueur*)..			x						x	
Heliophyllum exiguum *Billings*......										x
Heliophyllum halli *Edwards and Haime*........................	x	x	x		x	x	x			x
Michelinia convexa d'*Orbigny*.......			x			x	x			
Michelinia favositoidea *Billings*......				x		x	x			
Romingeria umbellifera (*Billings*)....							x			
Snathophyllum arundinaceum (*Billings*)...........................										x
Snathophyllum simcoense (*Billings*)..	x	x	x		x		x	x	x	x
Snathophyllum stramineum (*Billings*)							x			
Syringopora hisingeri *Billings*......					x	x	x		x	x
Syringopora maclurei *Billings*.......										x
Syringopora nobilis *Billings*.........			x			x	x		x	x
Syringopora perelegans *Billings*......		x	x	x	x	x	x		x	x
Zaphrentis gigantea *Leseuur*........	x	x	x	x	x	x	x	x	x	x
Zaphrentis prolifica *Billings*.........										x
Bryozoa										
Coscinium striatum *Hall and Simpson*										x
Fenestella parallela *Hall*............			x							
Fenestella sp......................								x	x	x
Fistulipora subcava (*Hall*)..........			x							
Reteporidra perundata (*Hall*).......										x
Unitrypa pernodosa (*Hall*)..........		x								
Brachiopods										
Amphigenia elongata *Vanuxem*......						x				
Atrypa reticularis (*Linnæus*)........			x		x	x	x			x
Camarotoechia billingsi *Hall*........									x	
Camarotoechia tethys (*Billings*).....			x							
Centronella glansfagea *Hall*.........			x							
Chonetes mucronatus *Hall*..........					x					x
Cyrtina hamiltonensis *Hall*.........			x							x
Delthyris raricosta *Conrad*..........			x							
Eunella lincklæni *Hall*..............			x							
Leptæna rhomboidalis (*Wilckens*)....										x
Meristella doris *Hall*...............										x
Meristella nasuta (*Conrad*)..........	x	x	x		x	x	x			x
Metaplasia disparilis (*Hall*).........			x						x	x
Orthothetes pandora (*Billings*)......			x			x	x			x
Parazyga hirsuta *Hall*..............										x
Pentamerella arata (*Conrad*)........		x	x		x	x				x
Reticularia fimbriata (*Conrad*)......										x

	Hogan Quarry.					Canadian Portland Cement Co's Quarry.				
	1	2	3	4	5	1	2	3	4	5
Rhipidomella cleobis (?) *Hall*........										x
Rhipidomella livia (*Billings*)........						x				
Rhipidomella vanuxemi *Hall*........			x							x
Schizophoria propinqua *Hall*........										x
Spirifer duodenarius (*Hall*).........			x		x				x	x
Spirifer varicosus *Hall*..............										x
Stropheodonta demisssa (*Conrad*)....			x				x			x
Stropheodonta hemispherica *Hall*....		x			x					x
Stropheodonta inequistriata (*Conrad*)			x				x			x
Strophonella ampla *Hall*............	x	x				x	x	x		
Trematospira gibbosa (?) *Hall*.......										x
Pelecypods										
Conocardium cuneus (*Conrad*)		x								x
Gastropods....................										
Diaphorostoma lineatum (*Conrad*)...		x	x	x	x	x	x		x	x
Diaphorostoma turbinatum (*Hall*)...			x							x
Diaphorostoma turbinatum cochleatum *Hall*......................										x
Loxonema pexatum *Hall*...........										x
Platyceras carinatum *Hall*..........					x					x
Platyceras conicum (?) *Hall*.........										x
Platyceras erectum (*Hall*)..........		x	x			x	x			
Platyceras rictum *Hall*.............										x
Paltyceras thetis *Hall*..............			x							
Strophostylus varians *Hall*..........										x
Turbonopsis shumardi (*de Verneuil*)..							x			
Crinoids										
Megistocrinus sp..................										
Trilobites										
Phacops cristata, *Hall*..............										x
Phacops rana (*Green*)..............			x							
Proetus rowi (*Green*)...............			x							

Lake Erie—Alt.: 571·57 ft.; 174·2 m. Lake Erie is 239 miles (384·6 km.) long and 59 miles (95 km.) wide; it covers an area of 10,000 square miles (25920 sq. km.); the mean elevation is 571·57 feet (174·2 m.) and the maximum depth 210 feet (64 m.) Lake Erie is the youngest of the great lakes, and owes its existence entirely to glacial and post-glacial agencies.

The north shore of Lake Erie is low and sandy with numerous bars and spits. Dunes form in many places, and shifting sands cause much trouble in the harbours and even to a considerable distance inland. There are few rock exposures on the water line, but near Port Colborne and at the western end of the lake, the Onondaga limestones are encountered a short distance inland.

Rondeau—At Rondeau the drifting sands have been piled up in long ridges parallel to the shore and now present a characteristic undulating contour. Behind the series of bars lies Rondeau harbour, and west of that an extensive peat bog which extends for several miles w th a width of from a quarter to a half mile. In depth, the peat varies from almost nothing to 30 feet (9·1 m.) in accord with the ridge-like bottom. Rondeau point, as well as most of the points along the north shore, owes its existence to a current which sets eastward along the coast.

Rondeau Provincial park occupies the peninsula of Point aux Pins and contains 1,950 acres (589 hectares) of wooded land which is probably the best example of the original forest to be found in the Western Peninsula. The ridge-like arrangement of the sand is well shown and is more pronounced on the lake side than on the harbour side. The tops of the ridges are about 12 feet (3·6 m.) above the water, while the depressions are about three feet (·9 m) above that level. Towards the west, the elevation is so much less that the depressions gradually become marshes and finally disappear beneath the lake. The soil is all fine, white, water-washed sand, and would support little vegetation if any except for the excellent sub-irrigation. Three distinct types of forest growth are presented as below:—

1. White pine belt along the lake front.

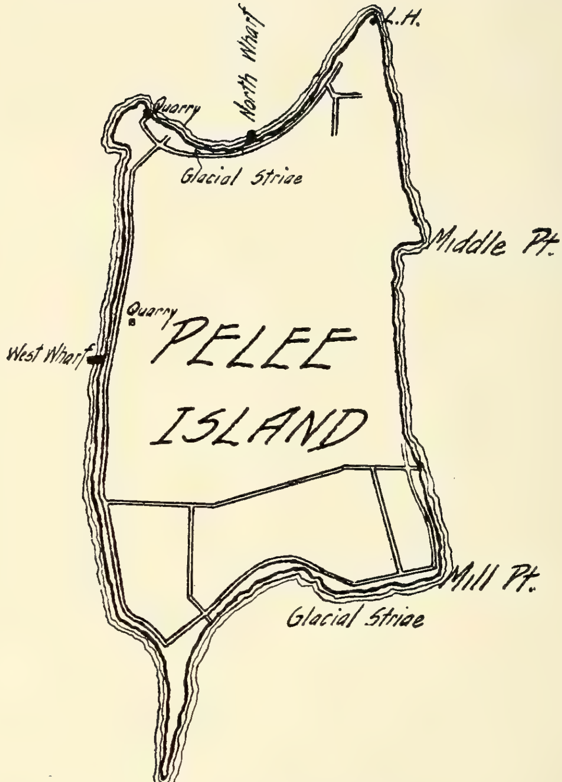
2. Hardwood growth on the ridges.
3. Hardwood growth in the depressions.

The most important trees are the following:—

On the ridges—
White pine, *Pinus strobus*, L.
Bur oak, *Quercus macrocarpa*, Michx.
Chestnut oak, *Quercus prinus*, L.
White oak, *Quercus alba*, L.
Hard maple, *Acer saccarinum.*
Beech, *Fagus ferruginea*, Ait.
Tulip tree, *Lyriodendron tulipifera*, L.
Basswood, *Tilia americana*, L.

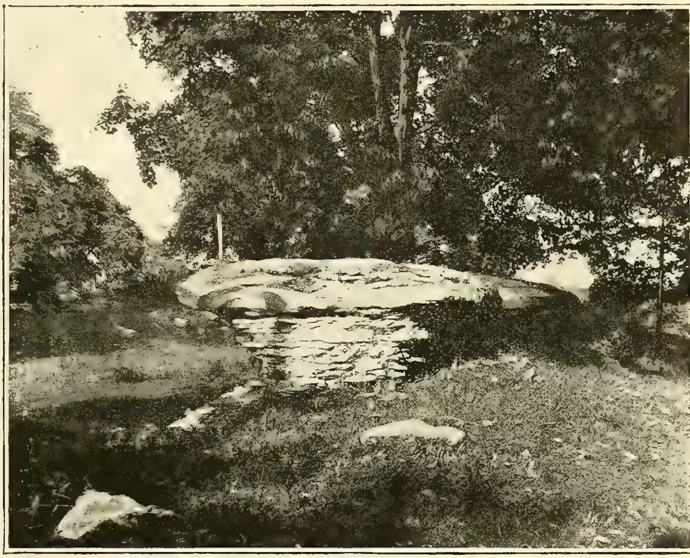
In the depressions—
Red oak, *Quercus rubra*, L.
Black oak, *Quercus coccinea tinctoria*, Gray.
Scarlet oak, *Quercus coccinea*, Wang.
Swamp white oak, *Quercus bicolor*, Willd.
Black ash, *Fraxinus sambucifolia*, Lam.
White elm, *Ulmus americana*, L.
Silver maple, *Acer dasycarpus*, Ehrh.
Red maple, *Acer rubrum*, L.
Bitternut hickory, *Carya amara*, Nutt.

In addition to the above there occur in less abundance black walnut, butternut, shellbark and mockernut hickories, yellow birch, sycamore, red elm, white ash, black cherry, white birch, aspen, large toothed aspen poplar, balsam poplar, hop hornbeam, blue beech and sassafras.



Sketch Map of Pelee Island.

Pelee Island—Thin and thick bedded dolomitic limestones of the Onondaga formation are exposed at many points on the island. Characteristic fossils may be collected in abundance at most of the



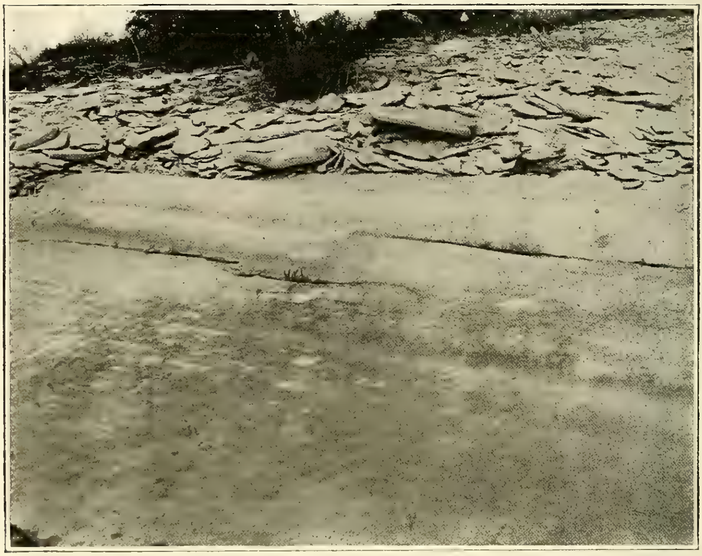
Ridges of Onondaga limestone formed by glaciers and subsequently weathered. Pelee island, Ontario.

outcrops. The more common species as occurring at a quarry on the west side of the island and at one near the north end are given below:—

	West Quarry.	North Quarry.
Rhizopoda—		
Calcisphæra robusta, *Williamson*	x	x
Hydrozoa—		
Clathrodictyon laxum, *Nicholson*	x	x
Stromatoporella granulata, *Nicholson*	x	x
Stromatoporella tuberculata, *Nicholson and Murie*		x
Anthozoa—		
Acervularia rugosa (*E. and H.*)	x	x
Cystiphyllum vesiculosum, *Goldfuss*	x	x
Eridophyllum verneuilianum, *E. and H*	x	x
Favosites emmonsi, *Rominger*	x	x
Favosites pleurodictoides, *Nicholson*	x	x
Favosites radiciformis, *Rominger*	x	x
Favosites turbinatus, *Billings*	x	x
Heliophyllum corniculum (*Lesueur*)	x	x
Heliophyllum halli, *E. and H*	x	x
Syringopora hisingeri, *Billings*		x
Syringopora tabulata, *E. and H.*	x	x
Zaphrentis gigantea, *Lesueur*	x	x
Zaphrentis prolifica, *Billings*	x	x
Bryozoa—		
Coscinium striatum, *Hall and Simpson*		x
Cystodictya gilberti (*Meek*)	x	x
Fenestella parallela, *Hall*	x	
Fenestella sp.		x
Monotrypella tenuis, *Hall*		x
Brachiopoda—		
Atrypa reticularis (*Linnæus*)	x	x
Camarotoechia billingsi, *Hall*		x
Camarotoechia carolina, *Hall*		x
Chonetes hemisphercus, *Hall*	x	
Chonetes mucronatus, *Hall*	x	x
Cyrtina hamiltonensis, *Hall*	x	x
Eunella lincklæni, *Hall*		x
Leptæna rhomboidalis (*Wilckens*)		x
Nucleospira concinna, *Hall*	x	x
Pentamerella arata (*Conrad*)		x
Pholidops patina, *H. and C.*		x
Productella spinicosta, *Hall*	x	x
Rhipidomella vanuxemi, *Hall*	x	x
Schizophoria propinqua, *Hall*	x	x
Spirifer acuminatus (*Conrad*)	x	x
Spirifer duodenarius (*Hall*)		x
Spirifer gregarius, *Clapp*	x	
Spirifer manni, *Hall*	x	x
Stropheodonta concava, *Hall*		x

	West Quarry.	North Quarry.
Stropheodonta demissa (*Conrad*)	x	x
Stropheodonta hemispherica, *Hall*	x	x
Stropheodonta perplana, (*Conrad*)	x	x
Pelecypoda—		
Aviculopecten princeps (*Conrad*)		x
Conocardium cuneus (*Conrad*)		x
Paracyclas elliptica, *Hall*	x	x
Gastropoda—		
Platyceras carinatum, *Hall*	x	
Pleuronotus decewi (*Billings*)	x	x
Pleurorema lucina (*Hall*)	x	x
Pteropoda—		
Tentaculites scalariformis, *Hall*	x	x
Crustacea—		
Coronura diurus (*Green*)	x	
Phacops cristata (*Hall*)		x
Prœtus rowi (*Green*)	x	x
Fish—		
Onychodus sigmoides, *Newberry*		x

Glacial grooving of a most pronounced and interesting character is shown at both the north and south extremities of the island; while, in the interior, long ridges of rock mark the path of the glacier. These ridges, modified by post-glacial weathering, present some very fine residual features.

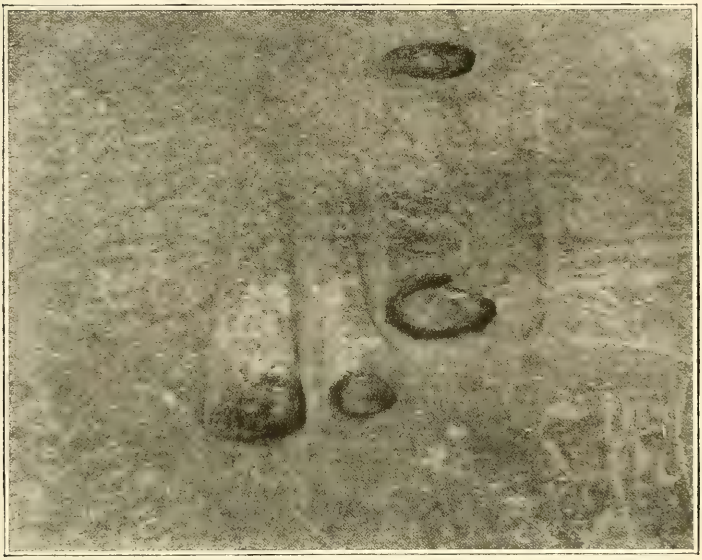


Glacial grooving in Onondaga limestone; south end of Pelee island, Lake Erie, Ontario.

Pelee island is the most southerly part of Canada, and was formerly a centre of the grape and wine industries; but, at the present time, it is largely given up to the culture of tobacco and corn.

Monroe Formation—The extreme western part of the province is so heavily covered by drift that exposures are rare. The upper rock belongs to the Onondaga and is comparable with that of Pelee island. In the Detroit river, however, and in the

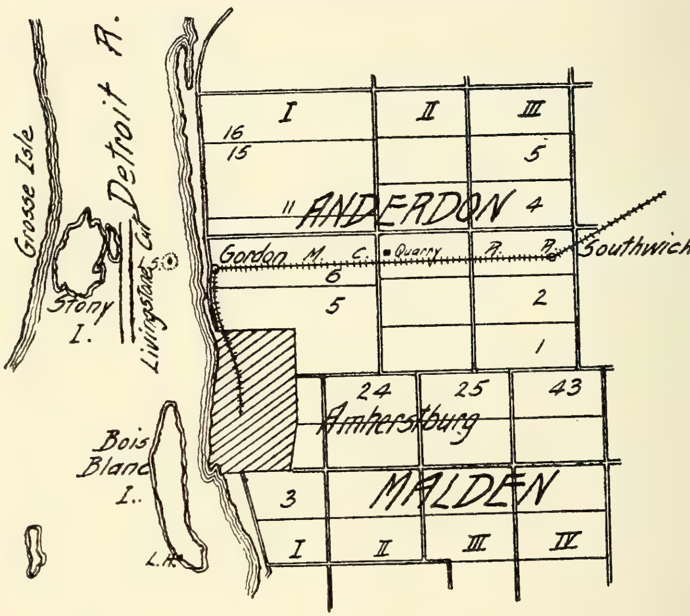
quarries at Amherstburg as well as at several points in Michigan, it is found that a series of formations lies between the Onondaga and the top of the Salina. American geologists propose to include all these layers in the Monroe formation and to ascribe them to the Silurian. The Monroe formation thus defined is divided into an upper and a lower division by the Sylvania sandrock.



Glaciated surface of Onondaga limestone showing the deflection of the ice around included corals, south end of Pelee island. Lake Erie, Ontario.

Amherstburg—Alt.: 593 feet; 180·27 m. Amherstburg, near the mouth of the Detroit river, is one of the historically important points in western Ontario: its origin during the French regîme is attested by the names of many of the present inhabitants. The first white men to ascend the Detroit river were LaSalle and Hennepin, who made the Amherstburg passage in 1679 in the ' Griffin." Since this time, $12,000,000 have been spent by the American government to improve he route. The necessity for this

expenditure is attested by the fact that a laden vessel passes Amherstburg every $13\frac{1}{4}$ minutes throughout the season of navigation. This vicinity was the scene of many stirring events during the war of 1812-14. The ruins of old Fort Malden may yet be seen within the limits of the present town. On the river Canard to the northward was fought one of the first skirmishes of the war.



MAP of ANDERDON and MALDEN TPS.

The extremely interesting section at the quarries of the Solvay Process Company is no longer visible in its entirety, as the excavation has been allowed to partially

fill with water. The upper beds are undoubtedly of Onondaga age, but the underlying strata have been the cause of considerable controversy The section in descending order is as follows:—

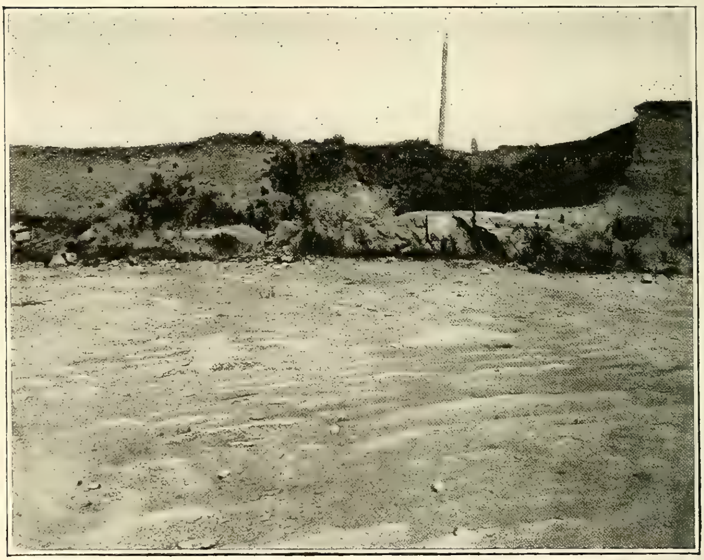
	Thickness.	
	Feet.	Metres.
Onondaga (*Devonian*)—		
1. Dolomitic limestone....................	35	10·64
Monroe (*Silurian*)—		
2. High grade limestone..................	24	7·29
3. Brown dolomites......................	4–5	1·2–1·5

1. The Onondaga l mestones are fossiliferous in places, but the locality can no longer be called a favourab!e collecting place. The following species are of common occurrence:—

Favosites hemispherica, *Yandell and Shumard.*
Michelinea convexa, *D'Orbigny.*
Streptelasma prolificum, *(Billings), Lambe.*
Syringopora hisingeri, *Billings.*
Atrypa reticularis, *(Linn.)*
Leptaena rhomboidalis, *(Wilckens.)*
Meristella nasuta, *(Conrad.)*
Reticularia fimbriata, *(Conrad.)*
Rhipidomella livia, *(Billings.)*
Spirifer varicosus, *Hall.*
Stropheodonta demissa, *(Conrad.)*
Stropheodonta inaequistriata, *(Conrad.)*
Stropheodonta perplana, *(Conrad.)*
Strophonella ampla, *Hall.*

2. A peculiarly ridged and undulat:ng surface is presented by the beds of high grade limestone, where the overlying Onondaga dolomites have been removed by quarrying. Grabau interprets this surface as of eolian origin and as having been made in early Devonian time. The underlying limestone (Anderdon beds) and the brown

dolomites beneath, he ascribes to the upper part of the Monroe formation, which is made to include all strata between the top of the Salina and the base of the Devonian.



Eroded surface of Anderdon high grade limestone with Onondaga dolomitic limestone in the background. Solvay Process Co's quarry. Amherstburg, Ontario,

The high grade Anderdon limestone is not rich in fossils, but it presents a coral and Stromatopora reef from which Grabau obtained the following species:—

Clathrodictyon ostiolatum, *Nicholson.*
Clathrodictyon variolare, *vonRosen.*
Idiostroma nattressi, *Grabau.*
Stromatopora galtensis *(Dawson.)*
Stylodictyon sherzeri, *Grabau.*
Ceratopora tenella *(Rominger.)*
Cladopora bifurcata, *Grabau.*
Cyathophyllum thoroldense, *Lambe.*

Cystiphyllum americanum anderdonense, *Grabau.*
Diplophyllum integumentum, *Barrett.*
Favosites basaltica nana, *Grabau.*
Favosites concava, *Grabau.*
Favosites rectangulus, *Grabau.*
Helenterophyllum caliculoides, *Grabau.*
Spirifer (Prosserella) lucasi, *Grabau.*
Pleurotomaria cf. velaris, *Whiteaves.*

The three Silurian stromatoporoids are of very doubtful identification; if these are excepted, the remaining fossils have a strong Devonian rather than Silurian aspect. Rev. Thomas Nattress of Amherstburg, who has studied the Anderdon limestone from the stratigraphic point of view, is convinced that it represents a Devonian sedimentation in an enclosed basin.

3. The underlying brown dolomites are not sufficiently exposed to yield important stratigraphic evidence: they appear to be destitute of fossils.

A second exposure of beds belonging to this series is furnished by the cut of the Livingstone canal in the Detroit river. The total length of the cut is 11 miles (17·7 km.), its width is 300 to 800 feet (91 to 244 m.) and its depth 23 feet (7 m.). Just above Amherstburg a section of the canal about a mile long was excavated within a coffer dam and is hence known as the dry cut. The material removed from the river bed, to an amount of 800,000 cubic yards, has been piled on either side of the cut and for a few years at least will be a good collecting ground for Monroe fossils.

Grabau maintains that these beds represent the upper part of the Monroe formation—above the Anderdon limestone, while Nattress as stoutly maintains that they belong to the lower Monroe. For our present purposes it will suffice to consider these beds as yielding an interesting series of fossils with both a Devonian and a Silurian aspect.

The commoner species are as follows:—

Hydrozoa

Clathrodictyon ostiolatum, *Nich.*
Idiostroma nattressi, *Grabau.*

Corals

Ceratopora regularis, *Grabau.*
Cladopora dichotoma, *Grabau.*
Diplophyllum integumentum (*Barrett.*)
Favosites tuberoides, *Grabau.*
Heliophrentis alternatum, *Grabau.*
Heliophrentis carinatum, *Grabau.*
Romingeria umbellifera (*Billings.*)
Synaptophyllum multicaule (*Hall.*)
Syringopora hisingeri, *Billings.*

Bryozoa

Fenestella sp.

Brachiopods

Schuchertella amherstburgense, *Grabau.*
Schuchertella interstriata (*Hall.*)
Spirifer (Prosserella) modestoides depressus, *Grabau.*
Spirifer sulcata submersa, *Grabau.*
Stropheodonta praeplicata, *Grabau*
Stropheodonta vasculosa, *Grabau.*

Pelecypods

Conocardium monroicum, *Grabau.*
Cypricardinia canadensis, *Grabau.*
Panenka canadensis, *Grabau.*

Gastropods

Acanthonema holopiformis, *Grabau.*
Eotomaria areyi, *Clarke and Ruedemann.*
Holopea antiqua pervetusta (*Conrad.*)
Hormotoma subcarinata, *Grabau.*
Lophospira bispiralis (*Hall.*)
Strophostylus cyclostomus, *Hall.*
Trochonema ovoides, *Grabau.*

Cephalopods

Cyrtoceras orodes, *Billings.*
Dawsonoceras annulatum americanum (*Foord.*)

Trilobites

Proetus crassimarginatus, *Hall.*

Vermes

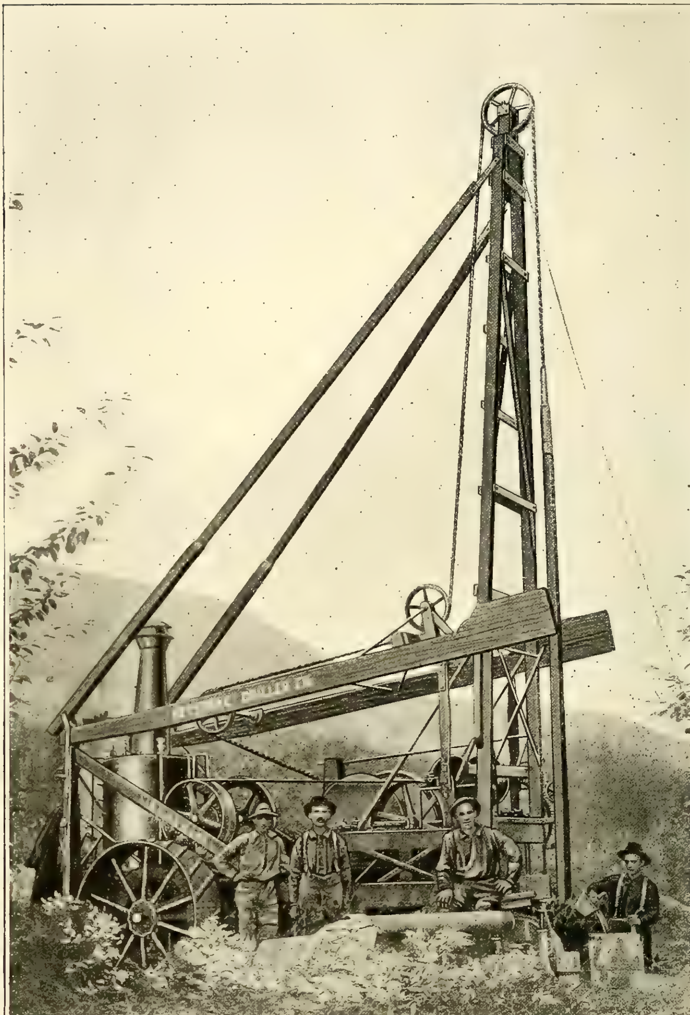
Cornulites armatus, *Conrad.*

Windsor—Alt.: 580 ft.; 176·3 m. The salt producing area of Ontario is situated about the southern end of Lake Huron and along the shores of River St. Clair, Lake St. Clair and Detroit river. The salt is derived from the Salina formation of the Silurian. The beds are encountered at a depth of about 1,000 feet (304·8 m.) from the surface, and they show, in some cases a thickness of more than 200 feet (60·9 m.)

The most important salt wells now in operation are situated near Windsor where the first well was sunk in 1892. The following log will serve to indicate the strata penetrated in this area:—

	Thickness.		Depth.	
	Feet.	Metres.	Feet.	Metres.
Drift	136	41·34	136	41·3
Limestone (Onondaga and Upper Monroe)	434	131·94	570	173·2
Sandstone (Sylvania)	136	41·34	706	214·6
Limestone (Lower Monroe)	350	105·4	1056	321·0
Salina	......	....	......	....

In drilling the wells, a ten inch mud casing is driven down to the solid rock, and forced into the stone sufficiently to render the joint watertight. The hole is then carried down with a diameter of 6¼ inches (15·8 c.m.) into the salt beds. A pipe, of the diameter of this hole, is extended about 800 feet (243·8 m.) to cut off mineral waters: in some cases, it is continued to about 1,300 feet (396·2 m.) in order to exclude the upper salt beds which are not quite as good as the heavier lower beds. A 3½ inch (8·9 cm.) pipe is placed inside the larger pipe and is extended to the bottom of the hole. Water is forced down between the two tubes and is made to ascend the inner tube after becoming saturated with salt. To lift the brine a one-inch air tube is carried down about 600 feet (182·8 m. inside the 3½ inch pipe. From this tube air is allowed to



Machine used in drilling salt wells.

escape under a pressure of 250 lbs., whereby a constant flow of brine is induced.

The average Windsor brine contains about 26·5% of sol ds made up as follows:—

Calcium sulphate..............	1·795
Calcium chloride..............	0·377
Magnesium chloride..........	0·124
Potassium chloride...........	tr.
Sodium chloride..............	24·2

The preparation of salt is effected by both the grainer and vacuum pan processes. At the Sandwich plant of the Canadian Salt Company, caustic soda is made by the electrolytic method, and the liberated chlorine is utilized for the manufacture of bleaching powder. This company produces 350 bbls. of grainer salt, 1,400 bbls. of vacuum salt, 2½ tons of caustic soda and 9 tons of bleaching powder per diem.

Thedford—Alt. 469·89 ft.; 142·84 m. The middle Devonian strata (Hamilton formation) lie in a syncline on the Onondaga limestones, and extend in a broad belt from Lake Huron to Lake Erie. The country underlaid by this formation is heavily covered with drift, so that exposures are seen at a few places only. The most noted localities are the vicinity of Thedford and the valley of the Aux Sables river between Rock Glen and Marshall's Mills.

For a full account of the geology of the Thedford region, with lists of fossils, etc., see the section on Thedford in the guide book to Excursion A12.

Lake Huron—Lake Huron is 207 mi es (333 km.) long, 100 miles (161 km.) wide and has an area of 23,200 square miles (60,134 sq. km.) The maximum depth is 750 feet (228·6 m.) and the elevation 579·86 feet (176 m.) At Kettle point near the southern end of the lake is an exposure of the highest Devonian strata in Ontario. The rocks consist of highly bituminous shales supposed to be equivalent to the Genesee shales of the New York geologists. Spherical concretions of brown crystalline calcite occur in these shales and sometimes reach a diameter of several feet. These concretions when half exposed above the waters of the lake resemble inverted kettles, and are responsible for the name of the point.

Goderich—Northward from this point, rock exposures are infrequent on the shores of the lake, but near Goderich a good section is revealed in the valley of the Maitland river. In descending order the following beds are exposed:—

	Thickness.	
	Feet.	Metres.
1. Soil and drift	50	15·2
Hamilton—		
2. Compact grey to drab limestone	9·5	2·89
Onondaga—		
3. Massive grey to brown crystalline limestone, with fossils	30	9·14
4. Brown crystalline coralline limestone	1·3	·40
5. Grey to brown limestone with numerous fossils at bottom	19·5	5·93
6. Grey crystalline limestone with pebbles of Silurian rock and quartz grains, fossiliferous		
Silurian (Monroe)—		
7. Thin-bedded bituminous limestones	2·5	·760
8. Fractured, buff limestone and dolomites	2·8	·861
9. Soft, mottled, yellowish, porous limestones and dolomites	5·5	1·67

The Hamilton strata are not particularly rich in fossils at this point, but a careful search reveals numerous species, of which the following are the more important:—

Corals

Cystiphyllum vesiculosum, *Goldfuss.*
Heliophyllum halli, *E. and H.*
Zaphrentis prolifica, *Billings.*

Hydrozoa

Stromatoporella sp.

Brachiopods

Atrypa reticularis (*Linnaeus.*)
Chonetes deflectus, *Hall.*

Chonetes mucronatus, *Hall.*
Chonetes scitulus, *Hall.*
Cranaena romingeri, *Hall.*
Crania crenistriata, *Hall.*
Craniella hamiltoniae, *Hall.*
Cyrtina hamiltonensis, *Hall.*
Delthyris consobrina (*d'Orbigny.*)
Eunella lincklaeni, *Hall.*
Leiorhynchus limitare (*Vanuxem.*)
Leptaena rhomboidalis (*Wilckens.*)
Lingula ligea, *Hall.*
Pentamerella arata (*Conrad.*)
Pholidostrophia iowaensis (*Owen.*)
Rhipidomella vanuxemi, *Hall.*
Schizophoria striatula (*Schlotheim.*)
Spirifer divaricatus, *Hall.*
Spirifer macrus, *Hall.*
Stropheodonta concava, *Hall.*
Stropheodonta demissa (*Conrad.*)
Stropheodonta perplana (*Conrad.*)

Pelecypods
Actinopteria boydi (*Conrad.*)
Aviculopecten bellus (*Conrad.*)
Nyassa recta, *Hall.*
Paracyclas elliptica, *Hall.*
Paracyclas linata (*Conrad.*)
Schizodus appressus (*Conrad.*)

Gastropods
Bembexia sulcomarginata (*Conrad.*)
Platyceras erectum (*Hall.*)
Pleuronotus decewié (*Billings.*

Pteropods
Tentaculites scalariformis, *Hall.*

Cephalopods
Centroceras ohioense (*Meek.*)
Gigantoceras inelegans (*Meek.*)
Orthoceras sp.

Trilobites
Proetus rowi (*Green.*)

The Onondaga strata contain typical Onondaga fossils as follows:—

Corals

Acervularia rugosa (*E. and H.*)
Favosites emmonsi, *Rominger.*
Favosites turbinatus, *Billings.*
Heliophyllum halli, *E. and H.*
Zaphrentis gigantea, *Lesueur.*

Bryozoa

Cystodictya gilberti (*Meek.*)
Fenestella parallela, *Hall.*
Fistulipora subcava (*Hall.*)
Monotrypa tenuis (*Hall.*)

Brachipods

Atrypa reticularis (*Linnaeus.*)
Atrypa spinosa, *Hall.*
Chonetes lineatus (*Conrad.*)
Cyrtina hamiltonensis, *Hall.*
Leptaena rhomboidalis (*Wilckens.*)
Pholidops patina, *Hall and Clarke.*
Pholidostrophia iowaensis (*Owen.*)
Productella spinulicosta, *Hall.*
Rhipidomella vanuxemi, *Hall.*
Schizophoria propinque, *Hall.*
Stropheodonta concava, *Ha.l.*
Stropheodonta demissa (*Conrad.*)
Stropheodonta hemispherica, *Hall.*
Stropheodonta patersoni, *Hall.*
Stropheodonta perplana (*Conrad.*)

Pelecypods

Conocardium cuneus (*Conrad.*)
Paracyclas elliptica, *Hall.*

Gastropods

Platyceras carinatum, *Hall.*
Pleuronotus decewi (*Billings.*)

Pteropods

Tentaculites scalariformis, *Hall.*
Proetus crassimarginatus, *Hall.*

Trilobites

Proetus rowi (*Green.*)

Flowerpot Island—Bruce peninsula, separating Lake Huron from Georgian bay, represents the unsubmerged edge of the Niagara cuesta: it is topped by the hard dolomitic limestone of the Lockport formation which rises, at one place in the county of Bruce, to a height of 400 feet (122 m.) above the lake.

Off the north shore of the peninsula are a number of small islands showing interesting residual structures; the chief of these is Flowerpot island, where huge masses of Lockport dolomite resembling giant vases are supported on diminished stalks of the softer underlying formation.

Cuesta topography, Wingfield basin, Manitoulin island.

Manitoulin Island.—The Grand Manitoulin island (The island of the Great Spirit) is stratigraphically a continuation of Bruce peninsula. The Niagara cuesta, which extends into the island, differs from the cuesta in the Bruce peninsula in that it approaches much closer to the oldland of the north shore of Lake Huron. In conse-

quence of this fact, the whole series of Palæozoic formations from the Niagara down to the Lowville is excellently shown within a comparatively short distance. The lower Ordovician deposits occur on the islands north of Manitoulin; the Collingwood is excellently shown near Little Current; magnificent exposures of the Lorraine and Richmond may be seen at the Clay Cliffs near Cape Smyth; and the Cataract and Niagara formations are excellently developed near Manitowaning.

THE GEOLOGY OF THE CLAY CLIFFS, CAPE SMYTH, MANITOULIN ISLAND.

by

August F. Foerste.

Cincinnatian Section at the Clay Cliffs.

The formations between the Trenton and the top of the Ordovician are generally referred to the Cincinnatian series. The order of succession of these formations, as exposed on Manitoulin island, is indicated in the following table.

Formations.	Thickness.	Characteristic Fossils.	Approximate horizon in Cincinnatian area.
Upper Richmond.....	50 to 60 ft. 15·2 to 18·3 m.	*Primitia lativia* *Rhytimya kagawongensis* *Ortonella hainesi* Manitowaning *Stromatocerium* reef.	Saluda with traces of Whitewater.
Middle Richmond....	30 to 50 ft. 9·1 to 15·2 m.	*Beatricea undulata* *Strophomena vetusta* *Ceraurus Meekanus* Cape Smyth *Stromatocerium* reef Gore Bay *Columnaria* reef.	Saluda with traces of Liberty.
Lower Richmond.....	40 to 50 ft. 12·2 to 15·2 m.	*Strophomena huronensis* *Strophomena sulcata* *Hebertella insculpta* horizon.	Upper Waynesville.
Lorraine.............	100 ft. 30·4 m.	*Whiteavesia pholadiformis* *Modiolopsis concentrica* in upper part.	Bellevue or Middle Maysville fauna in lower part.
Eden................	20 to 30 ft. 6 to 9·1 m. 100 ft. 30·4 m.	Interbedded limestones with *Cœloclema communis* *Dekayella ulrichi* Clays with *Triarthrus becki*, *Trinucleus concentricus*.	Southgate or Middle Eden.
Utica of New York....		Absent in Lake Huron area.	
Collingwood.........	20 to 30 ft. 6 to 9·1 m.	*Ogygites canadensis*.	

Collingwood formation.—The lowest formation, the Collingwood, formerly correlated with the Utica of New York, has been differentiated recently by Raymond, since it contains a sufficiently distinct fauna, although presenting the same lithological appearance. It consists of fissile black shales, and is well exposed on the hill in the eastern edge of Little Current.

Eden clays.—The lower part of the Eden consists of a great thickness of clay shale, 100 feet (30·5 metres) thick, with scarcely a trace of limestone. The fauna includes *Diplograptus peosta* and species of *Leptobolus* and *Primitia*, in addition to the trilobites mentioned in the table of formations. The best exposures are found three miles (5 km.) southeast of Little Current, along the road to Sheguindah.

Eden limestones.—Along the same road to Sheguindah the basal part of the overlying strata, consisting of limestones interbedded with clays, is exposed. The upper part of these strata may be seen immediately south of the great Richmond exposures on the eastern side of Cape Smyth. Here, owing to the southward dip of the strata, the top of the Eden limestone section is seen at the northern end of the Lorraine exposures which line the shore for several miles. From this upper part of the Eden section Ulrich and Bassler identified provisionally.:—

Amplexopora persimilis (variety of A. septosa *Ulrich*).
Callopora communis *James*.
Callopora sigillarioides *Ulrich*.
Coeloclema communis *Ulrich*.
Dekayella ulrichi *(Nicholson)*.
Stigmatella *near* nana *Ulrich and Bassler*.

A much larger fauua has been collected from other localities, as far west as Tamarac point and the eastern shore of Gore bay.

Lorraine.—A visit to the Clay Cliffs in the Cape Smyth area certainly should include at least a brief glance at the Lorraine exposures which line the shore at water's edge for nearly two miles south of the Clay Cliffs. Here,

clay shales are interbedded with fine-grained siliceous limestones, some of which weather to a brownish rock resembling fine-grained sandstone. This rock frequently contains an abundant pelecypod fauna, including:—

Clay Cliffs, Manitoulin island, showing Lorraine exposures in the background and Richmond in the distance.

Byssonychia radiata *(Hall)*
Cleidophorus planulatus *Conrad.*
Ctenodonta pectunculoides *Hall.*
Lydrodesma poststriatum *(Emmons).*
Modiolopsis concentrica *Hall and Whitfield.*
Whiteavesia pholadiformis *(Hall).*

These pelecypods are associated at least at one horizon, with *Diplograptus angustifolius* mut. *vespertinus* of the middle Lorraine of New York.

In Ohio, *Whiteavesia pholadiformis* and *Mediolopsis concentrica* come in at the base of the Waynesville member

of the Richmond and continue apparently into the Liberty, but the bryozoans, submitted to Dr. E. O. Ulrich, indicate a Bellevue or middle Maysville age, rather than a lower Richmond horizon.

Lower Richmond.—Capt Symth, at the northeastern corner of Manitoulin island, has long been known as a type locality for various Richmond fossils, but it is rarely visited by the geologist. This is due to the expense and the inconvenience attending a hasty visit in the absence of a camping outfit. Four miles south of Cape Smyth, the steep white Clay Cliffs rise to a height of over 200 feet (60 m.) above the level of the lake.

As frequently happens with such steep exposures, more than half of the slope of the cliff is cove ed w th talus, and only along the upper half of the cliff are the strata directly accessible. A Stromatocerium reef occurs 30 feet (9·1 m.) below the top of the cliff, and the overlying limestone strata present such a steep front as to be almost inaccessible. *Herbertella inscuplta*, (Hall), a form which demarcates the base of what here is included in the Lower Richmond, has a vertical range of about 10 feet (3 m.) at a horizon 30 feet (9·1m.) below the Stromatoceruim reef. The total thickness of the Lower Richmond at this locality, therefore, is about 40 feet (12·2 m.) .

The following fossils occur in the strata below the Stromatocerium reef but are not known above it —

Protarea richmondensis papillata *Foerste.*
Constellaria polystomella, *Nicholson.*
Rhombotrypa quadrata *(Rominger).*
Catazyga headi *(Billings.)*
Crania scabiosa *Hall*
Hebertella insculpta *Hall.*
Platystrophia clarksvillensis *Foerste.*
Plectambonites sericeus *(Sowerby)* (small variety).
Rafinesquina alternata *(Emmons)* (very flat form).
Strophomena huronensis *Foerste.*
Strophomena neglecta *James.*
Strophomena nutans *Meek.*
Strophomena planumbona *Hall (*S. rugosa *Blainville.)*
Cyclonema bilix *Conrad.*

Helicotoma brocki *Foerste.*
Ascoceras sp.
Spyroceras hammelli *Foerste.*

In addition to these there are many gastropods and pelecypods not as yet identified.

These fossils suggest the upper Waynesville division of the Richmond formation as exposed in Ohio, Indiana, and Kentucky. The following species occur not only below the Stromatocerium horizon, but range also into the strata above —

Strephochetus richmondensis *Miller.*
Stromatocerium huronense *Billings.*
Calapoecia huronensis *Billings.*
Columnaria alveolata *Goldfuss.*
Streptelasma rusticum *Billings.*
Tetradium huronensis *Foord.*
Hebertells occidentalis *Hall.*
Rhynchotrema perlamellosum (*Whitfield*).
Zygospira kentuckiensis *James.*
Zygospira modesta *Hall.*
Pterinea demissa (*Conrad*).

All these are spec'es which can exist under very adverse condit'ons in fairly muddy water.

Middle Richmond.—The thirty feet of strata which overlies the Stromatocerium reef at the Clay Cliffs belong to the lower part of the Middle Richomnd. Here, occasional specimens of *Beatricea undulata*, and rather numerous specimens of *Liospira helena*, and of various thick-shelled species of *Bucania* and *Bellerophon* occur.

The *Beatricea undulata* horizon is exposed also in the gully a short distance north of the light house at Manitwaning. Here, the Cape Smyth Stromatocerium reef is absent, and the corresponding horizon is approximately indicated by strata in which *Columnaria alveolata* and *Calapoecia huronensis* are fairly abundant. Eastward, this horizon is represented by the Gore Bay Columnaria reef. Three and a half miles south of Little Current, *Strophomena vetusta* and *Ceraurus (Eccoptochile) meekanus*, Miller, occur immediately above this Columnaria reef, and suggest a trace of the Liberty fauna of Ohio and Indiana, while the *Beatricea undulata*, the abundance

of *Columnaria alveolata*, *Calapoecia huronensis*, and *Tetradium* indicate the Saluda.

Upper Richmond.—At Manitowaning, a Stromatocerium horizon occurs far above any of the levels at which *Beatricea* has been found. This Manitowaning Stromatocerium reef limits the top of the Middle Richmond. It is widely distributed and has been traced as far west as Barrie island, west of Gore bay. In the vicinity of Kagawong it is overlaid by a horizon rich in silicified pelecypods, including *Cyrtodonta ponderosa*, *Ctenodonta iphigenia*, and *Ortonella hainesi*. The last named species suggests a trace of the Whitewater fauna, although *Leperditia caecigena*, *Primitia lativia*, and other ostracods occurring at numerous localities above the Manitowaning Stromatocerium reef, indicate the Saluda of Indiana.

Possibly the most interesting fact is the evidence that this Upper Richmond ostracod fauna, with some of its associated brachiopod and pelecypod species, occurs also in the western extension of the Queenston shales of New York, as exposed on the southern shores of Lake Huron between Collingwood and Owen Sound

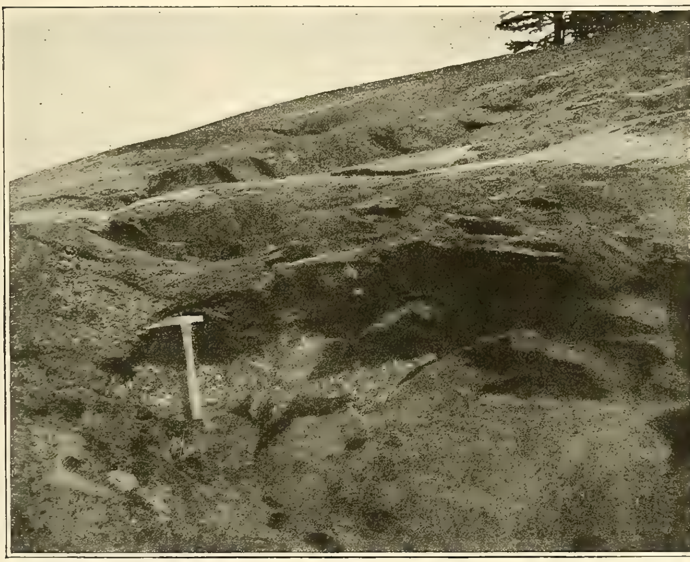
Fossils from the Clay Cliffs.—Among the fossils which have been described from the Clay Cliffs may be mentioned:—

Stromatocerium huronense *Billings*.
Calapoecia huronensis *Billings*.
Stroptelasma canadensis Billings (rusticum *Billings*).
Tetradium huronensis *Foord*.
Strophomena huronensis *Foerste*.
Ctenodonta iphigenia *Billings*.
Cyrtodonta ponderosa *Billings*.
Helicotoma brocki *Foerste*.
Liospira helena (*Billings*).
Cyrtoceras lysander *Billings*.
Cyrtoceras postumius *Billings*.
Orthoceras piso *Billings*.

To these might be added, as coming at least from the Lake Huron area: *Licrophycus hudsonicum*, Billings, from Manitowaning bay, *Cyclocystoides huronensis*, Billings, from the Beatricea undulata horizon on Rabbit island, *Vanuxemia bayfieldi*, Billings, from the Upper Richmond on Bayfield Sound, and *Cyrtoceras ligarius*, Billings, from the Richmond on Drummond island.

GRANITE ISLAND.

The Pre-Cambrian quartzites are exposed on many of the islands north of Manitoulin, and present interesting contacts with the low-lying Palæozoic strata. Extensive masses of granite have invaded the quartzites and are now exposed on several of the small islands between Mani oulin and the mainland. The coarse red granite of Granite



Residual Lowville limestone in cavities in granite. Granite Island, Lake Huron, Ontario.

island presents interesting contact phenomena with the quartzites, but it is particularly worthy of note on account of the occurrence of sedimentary limestone in kettle-like hollows at an elevation of 50 or 60 feet (15 to 18 m.) above the water of the lake. Fossiliferous strata of Lowville age occur along the north shore of the island at water level. These beds show a basal arkose covered by limestone layers with a strong cephalopod fauna represented for the

most part by the remains of siphuncles. Numerous gastropods and pelecypods also occur. The residual limestone and arkose, seen in the cavities in the granite, are essentially similar but lie at an elevation of 50 or 60 feet (15 to 18 m.) above the limestone on the shore. As the original hollows in the granite could not have been of great depth and as the length of time since the deposition of the limestone has not been sufficient to entirely wear them out, it follows that the total erosion of the granite since Lowville time has not been very great.

THE MOHAWKIAN (MIDDLE ORDOVICIAN) STRATA NORTHEAST OF MANITOULIN ISLAND.

BY

August F. Foerste.

Little Current—Alt. 579.86 ft. 176.3 m.—Little Current is the most important town on Manitoulin island. The narrow channel between Manitoulin and Goat islands, at this locality, forms the eastern exit for the lumber traffic along the waters of the North Passage. Lumber rafts are sometimes held up two or three days by the peculiar currents (seiches) which have given the village its name. These are due to the wind. When the wind blows strongly for several days in one direction it heaps up the water on one side of the passage at Little Current, and lowers it on the other sufficiently to start a current, the direction of which depends on the direction of the wind, whether from the east or from the west. Hence, such names as Little Current and Swift Current.

The most striking geological feature of the territory bordering the channel north of the main body of Lake Huron is the deposition of Ordovician strata upon a fairly rugged Pre-Cambrian topography. Here, strata as early as the Lowville clays and limestones, and as late as the Trenton and the immediately overlying Cincinnatian strata rest directly upon quartzites and schists mapped by the Geological Survey of Canada as Huronian. There is

evidence that these Huronian rocks had been considerably weathered before the deposition of the Lowville, and that the topography probably had become sufficiently dissected to give rise to ranges of hills or low mountains comparable in direction and altitude to those which now traverse the region.

Cloche Island.

An excellent section of the Mohawkian strata is exposed along the line of railway from Cloche peninsula, across Cloche island and Goat island to Little Current.

Lowville.—The lowest Palæozoic strata, exposed for several miles (4 or 5 km.) along the western margin of the Cloche peninsula, consist of red shales of Lowville age. Only the upper part of these shales, 70 feet (21 m.) thick, are exposed above lake level. Fossils are found a mile (1·6 km.) south of the northwestern angle of the peninsula, in a hard brownish clay stratum a short distance above the level of the railway. The southward dip of the strata is sufficient to carry them below lake level about a mile before Swift Current is reached. The following species are to be obtained from the hard brownish stratum:

Pterotheca cf. attenuata *(Hall).*
Cyrtodonta cf. janesvillensis *(Ulrich.)*
Archinacella sp.
Lingula sp.

Leray member of Lowville.—The overlying strata consist chiefly of soft whitish limestones of variable character, which are reddish only where near one of the Pre-Cambrian quartzite ranges or knolls, whose weathered surfaces furnished the ferruginous matter included in the later strata. These limestones are referred to the Upper or Leray division of the Lowville, and terminate, at the top, in a series of very fine grained, much harder limestones, 11 feet (3·3 m.) thick, resembling the "Birdseye" limestone of New York. These "Birdseye" limestones are exposed at intervals for a distance of almost a mile along the railway south of Swift Current, and contain very few fossils. The immediately underlying strata, exposed along the same stretch of railway, especially in the immediate vicinity of Swift Current, where they rest directly on a quartzite knoll, contain a fauna sufficient to identify the

horizon, although not usually well preserved. The more common fossils are:—

Escharopora ramosa (*Ulrich*).
Homotrypella instabilis *Ulrich*.
Monticulipora sp.
Rhinidictya fidelis (*Ulrich*).
Rhinidictya mutabilis (*Ulrich*).
Rhinidictya nicholsoni *Ulrich*.
Rhinidictya trentonensis (*Ulrich*).
Dalmanella cf. subæquata group
Rhynchotrema ainsliei *N. H. Winchell*.
Actinoceras bigsbyi (*Stokes*).
Bathyurus sp.

Black River Limestones.—Overlying the Leray division of the Lowville are darker limestones corresponding approximately to the Watertown limestones of New York and the Decorah shales of Minnesota. These are the beds to which formerly the term "Black River" was restricted, and these are the beds which present the best facilities for collecting. The lower part of the section, 80 feet (24 m) thick, with *Columnaria halli*, Nicholson, and a species of *Stromatocerium*, is exposed for a mile south of Swift Current. The upper part of the section occupies the remainder of the distance across Cloche island. The dip of these strata changes constantly, owing to their deposition among the ranges of Huronian quartzites and schists. The angle is so low and variable that it is impossible to determine, even approximately, the thickness of the various formations.

Species occurring only in the lower beds of the Black River:—

Stromatocerium rugosum *Hall*.
Columnaria halli *Nicholson*.

Species occurring in the upper half of the Black River; the forms marked * occur only at the top:—

*Calapœcia canadensis *Billings*.
*Columnaria alveolata *Goldfuss*.
*Petraia aperta *Billings*.
*Protarea vetusta *Hall, Billings*.
Receptaculites occidentalis *Salter*.
Solenopora compacta *Billings*.

Batostoma humile *Ulrich.*
Batostoma varium *U rich.*
Eridotrypa mutabilis *Ulrich.*
Nicholsonella ponderosa *Ulrich.*
Phyllodictya frondosa *Ulrich.*
Phylloporina sublaxa *Ulrich.*
Prasopora insularis *Ulr ch.*
Dalmanella gibbosa (*Billings*).
Hebertella bellarugosa (*Conrad*).
Rafinesquina inquassa *Sardeson*
Conradella obliqua *Ulrich.*
Maclurea logani *Salter.*
Actinoceras bigsbyi (*Stokes*).
Gonioceras anceps (*Hall*).
*Eurostomites undatus (*Emmons*).
*Plectoceras sp.
Triptoceras sp.

Pleistocene glaciation.—The Black River strata on Cloche island have been planed down to very flat surfaces, exposing glacial striæ over wide areas. *Gonioceras anceps*, *Receptaculites occidentalis* and *Maclurea logani*, fossils abundant in the upper half of these Black River limestones, can be readily identified on the glaciated surfaces.

Goat Island.

Trenton (Curdsville).—The lowest Trenton strata exposed along the line of railway, occur near the northeastern shore of Goat island, and are referred to the Curdsville division of Kentucky. They contain many of the species found in the underlying Black River limestones, but with the absence of *Gonioceras*, *Receptaculites* and *Maclurea*, and with the presence of a number of crinoids and cystids not seen in the underlying strata. Among these, *Carabocrinus vancourtlandi*, Billings, is common, and *Glyptocrinus ramulosus*, Billings, is represented by numerous columns of large size, but by few calices. The crinoids and cystids belong to species characteristic of the lower Trenton at Kirkfield, Ontario, and at Curdsville, Kentucky.

The species confined to this horizon are given below in list A. Species common to this horizon and to the underlying Black River are given in list B.

List A.	List B.
Callopora multitabulata (*Ulrich*)	Streptelasma profundum (*Conrad*)
Eurydictya multipora *Hall*	Batostoma winchelli (*Ulrich*)
Monticulipora? cannonensis *Ulr.*	Homotrypa minnesotensis *Ulr.*
Rhinidictya minima *Ulrich*	Dalmanella testudinaria (*Dalman*)
Rhinidictya mutabilis (*Ulrich*)	Dinorthis pectinella (*Emmons*)
Carabocrinus vancourtlandi *Bill's*	Orthis tricenaria *Conrad*
Cleiocrinus regius *Billings*	Plectambonites curdsvillensis *Foerste*
Cyclocystoides halli *Billings*	Rhynchotrema inæquivalve (*Castlenau*)
Glyptocrinus ramulosus *Billings*	"Rhynchotrema" ottawaense (*Billings*)
Lichenocrinus sp.	Strophomena filitexta *Meek*
Reteocrinus alveolatus *Miller and Gurley.*	Bumastus milleri (*Billings*)
	Leperditia fabulites *Conrad.*

Stromatocerium horizon.—Overlying this Curdsville horizon is one in which *Stromatocerium* is abundant. There probably is an unknown interval between this and the Curdsville, since most of the specimens of *Stromatocerium* are found along the southwestern side of Goat island.

Prasopora simulatrix horizon.—The lowest strata found at the water's edge directly east of Little Current represent a higher Trenton horizon. In the lower part of the section in this locality, 5 feet (1.5 m) thick, *Prasopora simulatrix* occurs in argillaceous limestone, accompanied by other bryozoans suggesting an age approximately comparable with the *Nematopora* bed or upper Prosser of Minnesota. Fossils occurring in these beds are:—

Anthroclema billingsi *Ulrich.*
Callopora multitabulata (Ulrich).
Dekayella trentonensis (*Ulrich*).
Eridotrypa mutabilis *Ulrich.*
Mesotrypa infida (*Ulrich*).
Mesotrypa cf. whiteavesi (*Nicholson*).
Monticulipora arborea *Ulrich.*
Prasopora simulatrix *Ulrich.*
Rhinidictya fidelis (*Ulrich*).
Rhynchotrema inaequivalve (*Castlenau*).
Strophomena sp.

Collingwood black shales.—East of Little Current, at an elevation of 50 feet (15 m.) above the lake, black fissile shales, to which Raymond has applied the term "Collingwood", rest upon Trenton strata containing *Tetradium*. At the base, these Collingwood shales are interbedded with limestones similar lithologically to the Trenton limestones beneath. Formerly, these shales were identified with the Utica of New York, but they contain a different fauna such as the trilobite long known as *Asaphus*, now *(Ogygites) canadensis*, also *Triarthrus fischeri*, and others. A thickness of only 11 feet (3.4 m.) of Collingwood shale is exposed on the hill east of Little Current, but the total thickness equals at least twice that amount. Three miles (4.8 km.) southeast of Little Current, on the "shore road" to Sheguindah, the Collingwood shales are overlaid by softer clay shales which form the base of the undoubted Cincinnatian section.

The common Collingwood fossils are:—

Diplograptus quadrimucronatus *Hall*.
Ogygites canadensis (*Chapman*).
Triarthrus fischeri *Billings*.

THE SILURIAN OF THE EASTERN PART OF MANITOULIN ISLAND.

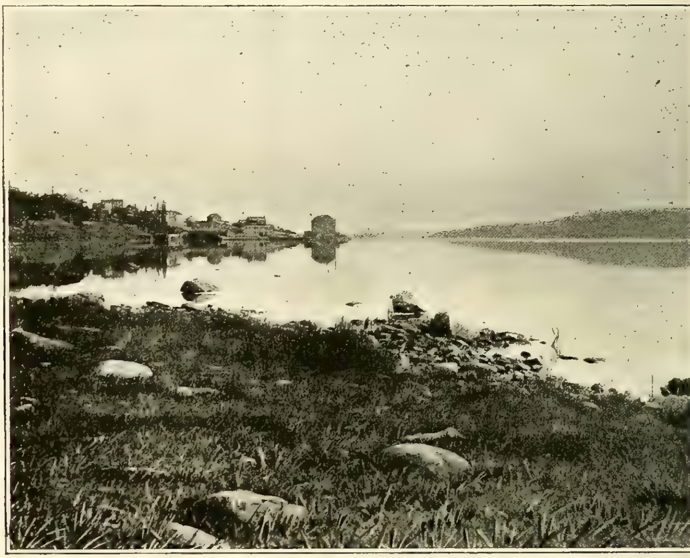
BY

MERTON Y. WILLIAMS.

INTRODUCTION.

History.—Manitowaning to-day shows few traces of its early history. Storehouses and a grist mill occupy the land jutting out from the front of the escarpment; the main town is on a higher level a short distance inland. A few buildings occupy the intermediate terraces, and on the rising slope above the wharves, the low rambling Indian Agency stands with its official flagstaff, though stripped of the stockade which once surrounded it. Where the agency now is, 1,500 Indians representing the Chippewa,

Ottawa and Saugin tribes, gathered in council, and consented to give up their control of the islands of Georgian bay and adjacent regions for a home on the Grand Manitoulin. The treaty referred to was made with Sir Francis Bond Head, Governor of Upper Canada (now Ontario) in 1836. Since then most of the island, being unoccupied



Manitowaning from the south. Manitoulin island, Ontario.

by the Indians, has been bought by white settlers and the aborigines are now confined to the reserves, the largest of which lies directly across the bay from Manitowaning. Besides being the home of the Indian Agent and the Indian doctor, Manitowaning enjoys a thriving trade with the Indians from the reserve.

Physiography.—The cuesta land-forms, so characteristic of the Palæozoic formations of the Georgian Bay region, are well developed in the vicinity of Manitowaning. The village is situated upon limestone strata of Richmond age which present a steep though sinuous front to Mani-

towaning bay. Inland, the firm dolomite of the Cataract formation rises as a low escarpment with irregular outline, and farther south, the Lockport dolomite rises as impressive cliffs 100 to 200 feet (30-60 m.) in height. This remarkable series of escarpments is the result of the wearing back from the Pre-Cambrian oldland of the edges of alternating hard and soft strata. The cliff-forming strata are either limestone or dolomite, and are underlain without exception by soft shales. The land surfaces, excepting the escarpments, are fairly level and tend to dip with the formation to the southwest at about 50 feet per mile (15 m. per 1.6 km.). Locally, glacial abrasion and glacial debris in the form of mounds and ridges have tended to confuse the otherwise symmetrical physiographic forms. Sorted, waterworn gravel, found in some localities, indicates the former submergence of all but the highest parts of the island.

Silurian Section.

The Silurian of Manitoulin island has been divided into two formations. The lower for which the term *Cataract* has recently been proposed, consists of 50 to 60 feet (15-18 m.) of dolomite overlain by 27 to 66 feet (8.2 to 20.1 m.) of red clayey shale. The upper or Lockport (Niagara) formation consists of at least 240 feet (73 m.) of dolomite.

Cataract formation.—The Cataract strata rest with apparent conformability upon the green shales at the top of the Richmond formation. The dolomite near the base is thin-bedded and argillaceous; midway up, thick beds of massive dolomite occur; and thin beds are again present near the top. Bryozoan and coral reefs, several yards in diameter, frequently occur within the upper 20 feet (6 m.) of the formation, and appear to have caused local thickening of the dolomite. In the lower shaly argillaceous dolomite, ramose bryozoans are plentiful and about 10 feet (3 m.) above the base *Leptæna rhomboidalis* has been sparingly found. The characteristic fossils of the formation occur mostly in the upper beds and are:—

Clathrodictyon vesiculosum *Nicholson and Murie*.
Acervularia gracilis (*Billings*).

Diphyphyllum cf. huronicum (*Rominger*).
Diphyphyllum multicaule (*Hall*).
Favosites aspera *d'Orbigny*.
Halysites catenulatus microporus (*Whitfield*).
Zaphrentis bilateralis (*Hall*).
Apiocystites tecumseth (*Billings*).
Pachydictya crassa (*Hall*).
Anoplotheca planoconvexa (*Hall*).
Atrypa cf. marginalis (Dalman).
Camarotoechia neglecta (*Hall*).
Orthis flabellites *Foerste*.
Platystrophia biforata (*Schlotheim*).
Rhipidomella hybrida (*Sowerby*).
Schuchertella subplana (*Conrad*).
Whitfieldella nitida (*Hall*).
Cyclonema cancellatum *Hall*.
Orthoceras sp.

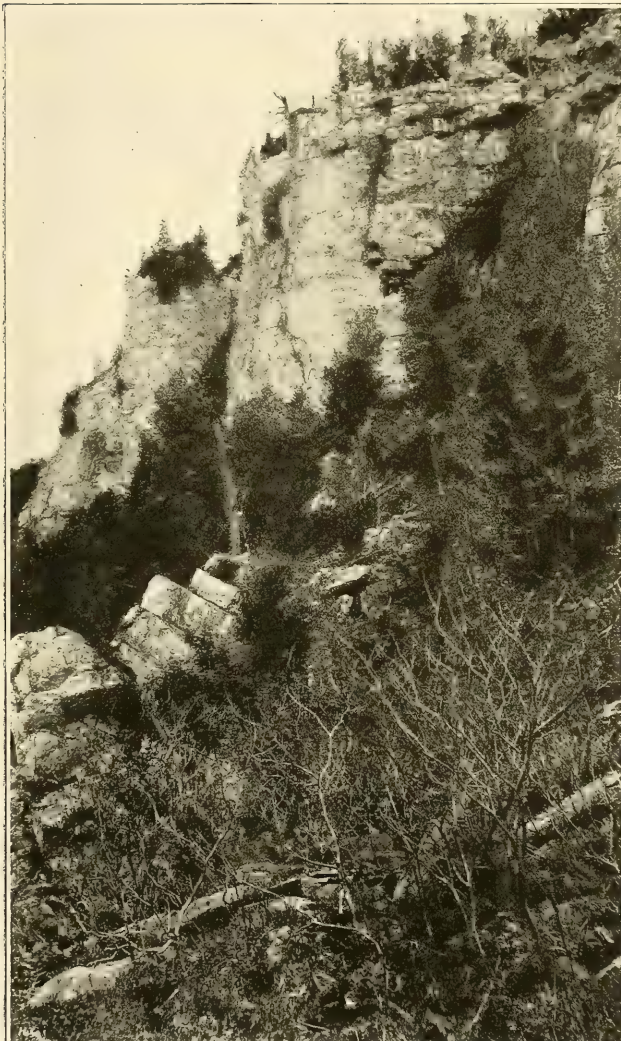
This formation is found to be the same as the *Cataract* at Cataract, Hamilton, and other places along the Niagara cuesta. It was formerly confused with the Clinton, but it undoubtedly lies below the typical Medina sandstone with *Arthrophycus*. On this account it has been erected into a new formation and includes the Whirlpool sandstone. (See guide books to Excursions B3 and B4.)

The shale of the Cataract formation has a clayey texture and is generally of an iron red colour. Some green discoloration occurs near the top due to leaching and consequent reduction of the iron bearing minerals. fossils have been found in the shale.

Lockport (Niagara) formation.—The Lockport formation consists of thin-bedded to thick-bedded, massive dolomites. At the base, directly above the red Cataract shale, the dolomite is thin-bedded and arenaceous, containing numerous *Pentamerus oblongus*.

A sparing coral fauna starts about 80 feet (24·4 m) above the base of the formation and reaches its maximum about 100 feet (30 m.) up. The last 30 feet (9·1 m.) of the formation, as occurring in the thickest sections studied, is massive and nearly unfossiliferous. The most characteristic fossils from the Lockport of Manitoulin island are:—

Arachnophyllum pentagonum (*Goldfuss*).
Arachnophyllum striatum (*D'Orbigny*).



Cliffs of Lockport dolomite, Thornbury, Ontario.

Chonophyllum belli (*Billings*).
Coenites laminata (*Hall*).
Cladopora laqueata *Rominger.*
Cyathophyllum radicula *Rominger.*
Diphyphyllum multicaule (*Hall*).
Favosites gothlandica (*Lamarck*).
Heliolites interstincta (*Linnaeus*).
Heliolites megastoma *McCoy.*
Heliolites pyriformis *Guettard.*
Omphyma verrucosa *Rafinesque and Clifford.*
Syringopora retiformis *Billings.*
Zaphrentis umbonata *Rominger.*
Orthis flabellites *Foerste.*
Atrypa sp.
Pentamerus oblongus *Sowerby.*
Stricklandinia sp. nov.
Platyostoma sp.
Orthoceras sp.

This formation above described is correlated on fossil evidence with the Lockport dolomite of New York State which is of Niagara age. It is this formation which forms the escarpment at Niagara Falls, and the almost continuous escarpment from Niagara to Manitoulin island.

Fossill Hill.

For 1·6 miles (2·57 km. south of Manitowaning the Richmond formation has produced a soil of excellent quality. In a corner of a field near the road the iron casing of a drill-hole may be seen. This is one of the many prospect holes driven within the past few years to test the oil production of the Trenton formation, here lying about 500 feet (152·4 m.) below the surface. Oil has generally been obtained, but so far, it is claimed that the quantity has not been sufficient to encourage the development of the field.

At the foot of a small hill, 1·6 miles (2·5 km.) from the village, the obscured contact between Ordovician and Silurian starata is crossed. East of the road, sorted gravel is exposed in a small pit. About 0·6 miles (0·7 km.) farther south, Cataract dolomite outcrops forming a prominent hill. The rock is composed of fossil coral reefs which appear to have thickened the dolomite locally. Several

of the corals common in the Cataract formation occur here. Farther south, the dolomite cliffs may be seen extending to the southeast. The road leads through fair farming country, but the good land is often interrupted by swamps, rock or glacial boulders. South of a small church, glacial mounds and ridges occur, and glacial materials obscure all else from there to Fossil Hill.

A long climb past the exposed edge of Lockport strata leads to the top of a plateau. A short distance to the north, along a beautifully wooded road, opportunity is afforded for collecting from the remains of a remarkable Lockport coral reef. Just below the little south-sloping grade, the ground should be carefully searched on both sides of the road. The Lockport corals are nearly all represented here, as well as other Lockport fossils including *Pentamerus oblongus*.

To the north of Fossil Hill, still higher beds of the Lockport formation are preserved, the dolomites measuring 240 feet (73 m.) in thickmess. The Fossil Hill horizon corresponds with that of maximum faunal development about 100 feet (30 m.) from the base of the formation.

THE ROCK.

The prominent escarpment, known as "The Rock", situated a short distance southwest of Manitowaning, is composed of dolomite of the Cataract formation. If one ascends the rock and continues westward from the brow for half a mile, a rocky knoll covered with sumach bushes will be observed. Here, the massive, jointed rock is composed of the remains of a coral reef. The reef builder appears to have been *Diphyphyllum* cf. *huronicum* which was associated, particularly near its edges, with *Orthoceras* sp., stromatoporoids and crinoid colonies, the latter represented by numerous columnar remains. Other fossils found at this locality are:—

Chonophyllum belli *Billings*.
Diphyphyllum multicaule (*Hall*).
Favosites *aspera d'Orbigny*
Halysites catenulatus micropora *Whitfield*.
Orthis flabellites *Foerste*.
Platystrophia biforata (*Schlotheim*).
Rhipidomella hybrida (*Sowerby*).

Northward the rock drops sheer for about 30 feet (9.1 m.) and great open joints are preparing the way for further recession of the front of the formation. In one place, a pinnacle of rock has been undermined and has tilted away from its original place, forming what is locally known as the "Devil's Needle". East of this point, a descent may be made, and the coral reef and underlying strata may be studied in section. A thickness of 40 feet (12.2 m.) in all is exposed along the cliff front. The upper 12 feet (3.6 m.) of strata are, in places, decidedly massive, the next 3 or 4 feet (.9 or 1.2 m.) are thin-bedded, and below these again the formation is massive. Few fossil remains appear on the edges of the strata.

A general prospect of Manitowaning bay and the surrounding country may be obtained from this cliff. The pole tripod to the north of the main road marks the location of a drill hole which taps the Trenton at a depth of about 440 feet (134 m.) and always contains some oil. Three other wells were drilled nearby, one to the west being 566 feet (172.5 m.) in depth.

From the Devil's Needle, a path leads easterly across partly-wooded pasture land to flat fields with much exposed rock. Some time may be profitably spent here collecting fossils. Nearly all the brachiopods and most of the corals common in the Cataract formation occur at this locality. It was from South bay that the type specimens of *Apiocystites tecumseth*, Billings, were obtained. The species is to be found at this locality. Continuing eastward the edge of the dolomite is soon reached and nearby is a small bryozoan reef, easily located by its outcrop, a mound of massive rock. The reef extends about 100 feet (30 m.) along the edge of the cliff, and is probably 20 feet (6 m.) thick at its centre. Its relation to the regularly bedded strata may be seen from the top of the cliff. Small ramose bryozoa, together with a small branching coral, appear to have been the reef builders. Small growths of *Favosites* and little cup corals lived about the reefs, as did also some brachiopods, e.g. *Platystrophia biforata*. About 0·05 mile farther south, a still larger reef occurs. An opportunity for examining a good section of this repays one for the trouble of climbing down over the edge of the beds among the loose rocks. Massive rock from 12 to 20 feet (3.6 to 6 m.) thick interfingers at its edges with bedded rock, and some of the underlying strata are flexed down-

wards. The reef has been of elliptical outline and is now about 300 feet (91 m.) long by 20 feet (6 m.) wide. The main rock mass appears to have been made up of the remains of *Diphyphyllum* cf. *huronicum* and small ramose bryozoan remains. Fossil Hill and "The Rock" furnish representatives of the whole Silurian section except the red Cataract shales which are nearly everywhere obscured.

Richmond exposures.—Northward from the fossil reef above described and about .4 of a mile south of the school, good exposures of the Richmond may be seen in a field. This horizon contains *Stromatocerium* and is probably 20 feet (6 m.) below the base of the Cataract dolomite. Some distance northward from this point along the shore of Manitowaning bay, a small water channel has worn its way into the edges of the Richmond limestones and shales. Some rather unsatisfactory exposures of limestone interbedded with shale may be seen between the top of the escarpment and the road. The section down to the water's edge consists of 12 feet (3.6 m.) of limestone at the top, underlain by interbedded grey limestone and soft shale. About 21 feet (6.4 m.) above the lake a six foot (1.8 m.) bed of firm limestone outcrops. Fossils are most plentiful in the lower beds, but may be found throughout the section. The talus along the water's edge contains many of the larger fossils, especially the corals. Graptolites occur in a firm, green, limy shale at the water's edge. Fossils found at this locality include:—

Beatricea undulata *Billings*.
Columnaria alveolata *Goldfuss*.
Streptelasma rusticum *Billings*.
Tetradium fibratum *Safford*.
Rafinesquina *sp*.
Rhynchotrema capax (*Conrad*).
Zygospira kentuckiensis *James*.
Byssonychia radiata (*Hall*).
Orthoceras sp.

THE KILLARNEY PASSAGE.

The little village of Killarney, on the north shore of Lake Huron, is a picturesque and interesting point. As the centre of an extensive fishing industry, Killarney enjoys a certain commercial prosperity, while the magnificent

scenery in the vicinity has made it an objective point for the tourist.

On entering Killarney bay from the south-west, the white peaks of quartzite rising to an elevation of nearly 1,000 feet (304 m.) above the lake form an impressive scene, which is enhanced by the scattered patches of dark green evergreens. The quartzite ranges are separated from the Laurentian gneisses to the east by a belt of granite, which forms the greater part of George island, between which and the mainland lies the Killarney passage. This channel is a straight east and west depression in the granite, of sufficient depth to allow the passage of large vessels. On Badgeley point, to the westward, a similar depression is cut almost to the water level. Here several dykes of greenstone run parallel to the depression, and a dyke of like material occurs in the granite south of the Killarney passage. It is probable that these depressions are in some way connected with the occcurrence of greenstone dykes [**33**].

THE PRE-CAMBRIAN OF PARRY ISLAND AND VICINITY.

BY

T. L. Walker.

Along the eastern shore of Georgian bay, from Killarney to the mouth of the Severn river, the rock formations are almost entirely made up of crystalline schists with numerous intrusions of acid and basic rocks. Some of the schists are derived from the alteration of igneous rocks, while others represent metamorphosed sediments.

In the vicinity of Parry Sound the general strike of the schists is north-easterly with a dip toward the southeast. Along the channel between Parry island and the mainland, the rocks are well exposed and exhibit outcrops of crystalline limestone, hornblende and biotite gneisses, and hornblende schist, while the intrusives are represented by anorthosite, gabbro, and granite. These igneous types have been subjected to such great pressure as to present

massive and foliated types closely associated with one another.

Locality 1.—Half a mile east of the Indian village on Parry island, the shore rock is entirely made up of massive gabbro. The rock consists of purplish plagioclase, fresh augite, and a little red garnet.

Banded gneiss near Sans Souci, Georgian bay, Ontario.

Locality 2.—On the peninsula to the east of the deep bay one mile and a half east-northeast of Locality 1 the same type of gabbro may be seen, but is here intimately associated with pressure products. Sometimes the only change is the granulation of the rims of the plagioclase, as is shown by the white border surrounding the purplish unaltered plagioclase core. In other places the alteration in structure may be traced through flaser gabbro, augen gabbro, gabbro schist to a garnetiferous gneissoid rock. The shore of Parry island, from the railway bridge to

Locality 1, is composed of rocks genetically related to gabbro.

Locality 3.—At the Bear's Head, near the entrance to the bay at the extreme south of Parry island, three rock types are observed. On the west shore of the bay, anorthosite forms high ridges bordered on the east by crystalline limestone. The strike of these rocks is north-northeast, with a dip to the eastward. The anorthosite exhibits slight parallelism near the contact with the limestone, but a few rods to the west it becomes quite massive. The east shore of the bay is made up of gneisses, more or less hornblendic, and following the same dip and strike as the anorthosite, and limestone.

Locality 4.—Pierce island, 3 miles (4·8 km.) south of the Bear's Head, exhibits crystalline schists of a different type. The rock is composed of alternate layers of light and dark bands, wonderful for the sharpness of the boundary lines between the bands and for the persistence of the individual members. This complex strikes north and south and has a vertical dip. The dark bands are largely of hornblende with smaller proportions of plagioclase, while the light bands represent a fine grained granite. The rock in the individual bands is always massive. The material of this banded complex appears to be igneous, but it is difficult to conceive of conditions accounting for the peculiar relationship exhibited.

Locality 5.—The rocks along the east shore of the channel between Pierce island and Parry Sound closely resemble those exhibited at Locality 4, except that the strike swings to the northeast, while the dip to the southeast is quite marked. The channel appears to indicate a line of great pressure, as may be seen at Locality 5 on the east side of Isabella island, where a very granular grey gneiss may be observed showing large augen of orthoclase and hornblende.

PALEOZOIC SECTION AT COLLINGWOOD.

The town of Collingwood has a population of about 8,000: it is situated on an excellent harbour, and has long been known as a port and shipbuilding centre.

The Blue mountains are visible from Collingwood and rise to a height of more that 1,000 feet (304 m.) above the

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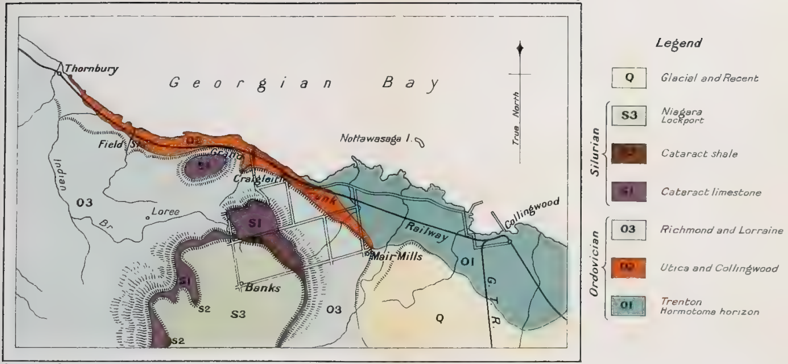

Geological Survey, Canada

Route map between Collingwood and Craigleith

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lake. In the immediate vicinity of the town the elevation is about 850 feet (259 m.) in which the following geological succession is presented:—

	Thickness.	
	Feet.	Metres.
SILURIAN.		
10–Lockport dolomite	75	22·8
9–Cataract shales	35–40	10·6–12
8–Cataract limestone	15	4·5
ORDOVICIAN.		
7–Richmond red and green shales	235	71·1
6–Richmond grey shales and limestone	50	15·2
5–Lorraine shales and arenaceous limestone	190	57·7
4–Eden shales	175	53·2
3–Utica shales (Upper Utica)	50–55	15.2–16.7
2–Collingwood shales (Lower Utica)	25	7·6
1–Trenton limestone (at water level)	?	?

Trenton formation.—The upper Trenton limestone (*Hormotoma* zone) is exposed on the shore line a short distance west of Collingwood. The strata are of little vertical extent, but they are rich in the fossils characteristic of the upper zone of the Trenton. The more common species are as follows:—

Corals—
Streptelasma sp.

Brachiopods—
Cyclospira bisulcata (*Emmons*). Abundant.
Dalmanella testudinaria (*Dalman*). Abundant.
Hebertella bellirugosa (*Conrad*). Rare.
Lingula cobourgensis *Billings*. Abundant.
Lingula sp.
Platystrophia biforata (*Schlotheim*). Rare.
Plectambonites sericeus (*Sowerby*). Abundant
Rafinesquina alternata (*Emmons*). Abundant.
Rafinesquina alternata nasuta (*Conrad*). Abundant.

Gastropods—
Conularia trentonensis (*Hall*). Abundant.
Cyclonema sp.
Fusispira notabilis *Ulrich*. Rare..
Fusispira sulcata *Ulrich*. Rare.
Hormotoma bellicincta (*Hall*). Rare.
Hormotoma gracilis (*Hall*). Rare
Hormotoma trentonensis *Ulrich*. Abundant.
Liospira angustata *Ulrich*. Rare.
Protowarthia cancellata (*Hall*). Rare.

Pelecypods—
Ambonychia sp.
Vanuxemia obtusifrons *Ulrich*. Abundant.

Cephalopods—
Orthoceras sp.

Trilobites—
Bronteus sp.
Calymmene callicephala *Green*. Common
Ceraurus pleurexanthemus *Green*. Fairly common.
Isotelus gigas *Dekay*.

Collingwood formation.—Resting directly on the Trenton limestones is a series of thin bedded limestones and dark bituminous shales, which is characterized more particularly by the presence of *Ogygites canadensis*, (*Chapman*). Raymond considers that this series of limestones and shales lies below the typical Utica of New York and has proposed the name "Collingwood" for the formation. The chief fossils are as follows:—

Graptolites—
Climacograptus bicornis (*Hall*).

Brachiopods—
Dalmanella testudinaria (*Dalman*).
Lingula cobourgensis *Billings*.
Lingula modesta *Ulrich*.
Lingula progne *Billings*.
Rafinesquina alternata (*Emmons*).
Rafinesquina deltoidea ((*Conrad*).
Rafinesquina minnesotaensis (*Winchell*).
Zygospira modesta (*Hall*).
Conularia trentonensis *Hall*.

Pelecypods—
Ctenodonta medialis *Ulrich.*
Modiolopsis nana *Ulrich.*
Cephalopods—
Endoceras proteiforme *Hall.*
Triolbites—
Calymmene callicephala *Green.*
Ceraurus sp.
Ogygites canadensis (*Chapman*).
Triarthrus beckii *Green.*

Utica formation.—Overlying the Collingwood formation is a series of shales of a somewhat less bituminous character which is correlated with the typical Utica of New York. The more common fossils are:—

Dalmanella testudinaria (*Dalman*).
Leptobolus insignis *Hall.*
Plectambonites sericeus (*Sowerby*).
Rafinesquina alternata (*Emmons*).
Endoceras proteiforme *Hall.*
Calymmene callicephala *Green.*
Triarthrus spinosus *Billings.*
Ostracods *sp. indet.*

Eden formation.—At Craigleith, the Eden shales are exposed directly above the Utica. The common fossils are:—

Dalmanella testudinaria emacerata (*Hall*).
Plectambonites sericeus (*Sowerby*).
Trinucleus concentricus *Eaton.*

Lorraine formation.—The Lorraine shales are not actually exposed at this point but the fossils characteristic of the formation may be obtained from the talus. The species are the same as those already mentioned from the Clay Cliffs, Manitoulin island.

Richmond formation.—The grey Richmond shales and limestones are not exposed in the section at Craigleith, but they show to better advantage on the road between Mair's Mills and Banks. The fossils are practically the same as those from the Richmond exposure at the Clay Cliffs, Manitoulin island.

The red and green shales of the Richmond are not well exposed, but fossils characteristic of the formation are

common in the talus derived from this member. This fact is of great stratigraphic importance, as farther south the member is entirely unfossiliferous and has been ascribed to the Medina.

Cataract formation.—The lower Cataract limestones and shales contain practically the same fauna as at Cataract (See guide book to Excursion B 4).

The upper or more shaly part of the Cataract is very much covered with talus, nevertheless some fossils characteristic of the formation may be obtained from this member.

Lockport formation.—The heavy dolomitic limestone of the Niagara (Lockport) forms the top of the section, and, owing to its white appearance, constitutes a conspicuous element in the landscape. Percolating waters have formed some interesting caves in the dolomite near Mair's Mills. A few fossils may be collected here, but the locality is by no means a rich collecting ground for Lockport species.

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ILLUSTRATIONS.

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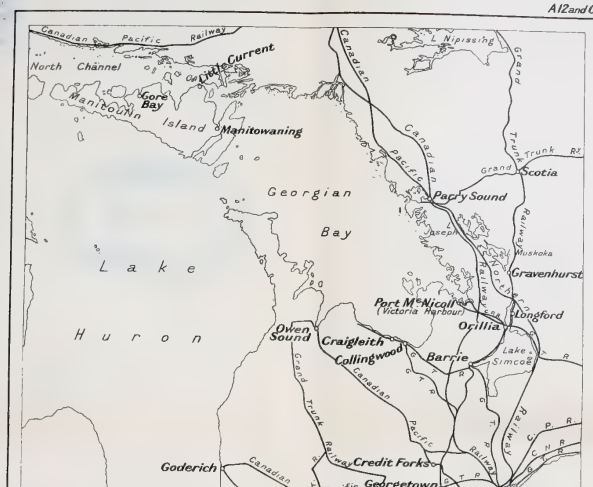

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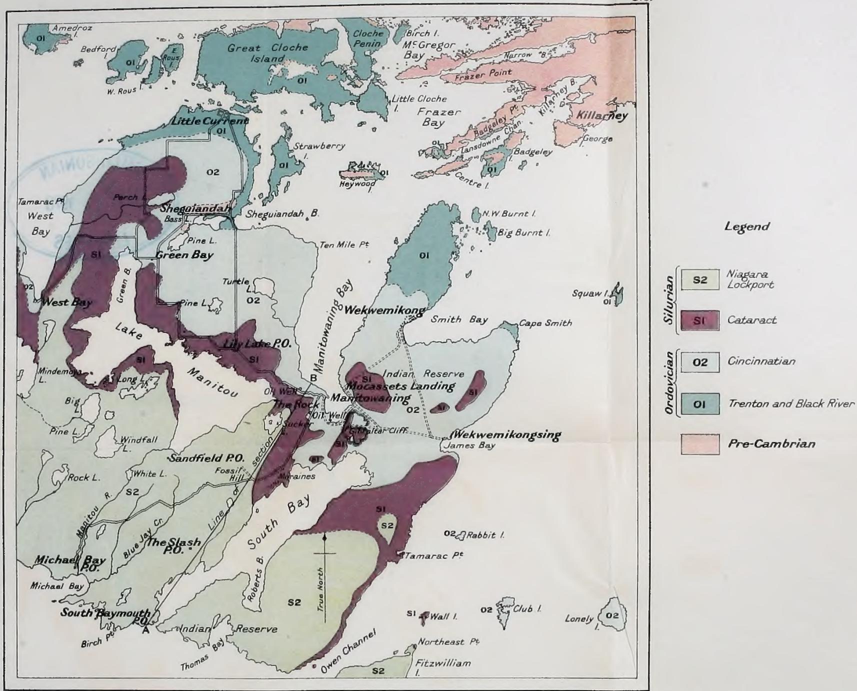
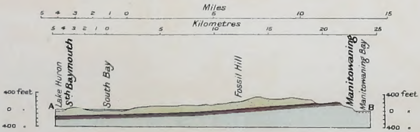
Route map between **Toronto** and **Manitoulin Island**



Geological Survey, Canada.

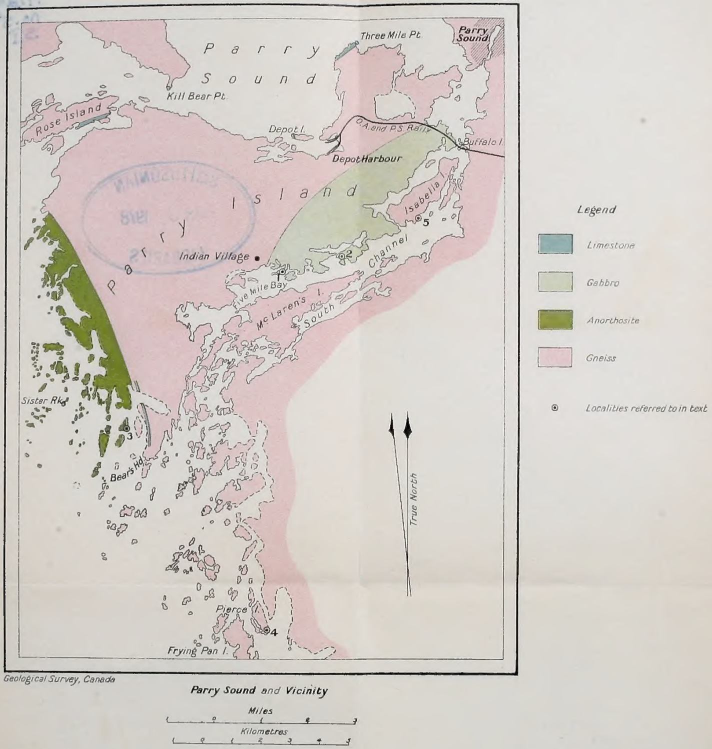
Eastern portion of **Manitoulin Island**



Section along line A B

Horizontal scale
0 1 2 3 4 5 miles

Vertical scale
0 800 1600 feet



Geological Survey, Canada

Parry Sound and Vicinity

Miles

Kilometres